PhD Science® K–5 Curriculum Correlation to *Kentucky Academic Standards for Science*

Contents

PhD Science® K–2 Curriculum Correlation to *Kentucky Academic Standards for Science*: Level K

The *PhD Science* Level K curriculum fully aligns with the Kindergarten *Kentucky Academic Standards for Science*. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Kindergarten

Performance Expectations: Physical Science		**Aligned *PhD Science* Lessons**
K-PS2-1	Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.	Level K M2 L1–23
K-PS2-2	Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.	Level K M2 L17–23
K-PS3-1	Make observations to determine the effect of sunlight on Earth's surface.	Level K M1 L8–11, 28–30
K-PS3-2	Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.	Level K M1 L12–16, 28–30

Performance Expectations: Life Science		**Aligned *PhD Science* Lessons**
K-LS1-1	Use observations to describe patterns of what plants and animals (including humans) need to survive.	Level K M3 L4–16, 19–22, 27–29

Performance Expectations: Earth and Space Science		**Aligned *PhD Science* Lessons**
K-ESS2-1	Use and share observations of local weather conditions to describe patterns over time.	Level K M1 L1–11, 17–24, 28–30 Level K M4 L25
K-ESS2-2	Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.	Level K M4 L1–10, 14–16, 26–28
K-ESS3-1	Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.	Level K M3 L1–3, 9–29 Level K M4 L1–2, 8–9, 11–13
K-ESS3-2	Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.	Level K M1 L22–30
K-ESS3-3	Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.	Level K M4 L14–24, 26–28

K–2 Engineering Design

Performance Expectations: Engineering, Technology, and Applications of Science		Aligned *PhD Science* Lessons
K–2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	Level K M1 L12–16
K–2-ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	Level K M2 L17–20
K–2-ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	Level K M4 L20–24

Science and Engineering Practices

Asking Questions and Defining Problems	Aligned *PhD Science* Lessons
Ask questions based on observations to find more information about the natural and/or designed world(s).†	Level K M1 L1–3, 22–26 Level K M2 L1–3, 9 Level K M3 L1–3, 14–16, 27–29
Ask and/or identify questions that can be answered by an investigation.	Level K M1 L8–9 Level K M3 L4–8, 22
Define a simple problem that can be solved through the development of a new or improved object or tool.†	Level K M1 L4–7, 12–16

Developing and Using Models	Aligned PhD Science Lessons
Distinguish between a model and the actual object, process, and/or events the model represents.	Level K M1 L1–2, 12–16 Level K M2 L1–3, 10–12
Compare models to identify common features and differences.	Level 1 M1 L11–15 Level 1 M2 L1–3 Level 2 M4 L1–6, 20–21, 23–25
Use a model to represent relationships in the natural world.†	Level K M3 L1–3, 9–12, 19–20 Level K M4 L1–9, 11–16
Develop a simple model based on evidence to represent a proposed object or tool.†	Level K M1 L12–16

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
With guidance, plan and conduct an investigation in collaboration with peers.†	Level K M2 L7–8, 10–15 Level K M3 L4–8
Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.	Level 1 M1 L19–20 Level 1 M2 L15–18 Level 2 M2 L8–12 Level 2 M3 L3–7 Level 2 M4 L17–19
Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.	Level K M4 L3–5
Make observations (firsthand or from media) to collect data that can be used to make comparisons.†	Level K M1 L4–7, 10–11, 17–24, 27–30 Level K M2 L7–8, 16–23 Level K M3 L21
Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.	Level K M1 L4–7, 12–20 Level K M2 L17–20
Make predictions based on prior experiences.	Level K M2 L13–15 Level K M3 L4–8

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Record information (observations, thoughts, and ideas).†	Level K M1 L4–7, 22–24 Level K M2 L4–6, 21–23 Level K M3 L1–3, 9–16 Level K M4 L14–16
Use and share pictures, drawings, and/or writings of observations.	Level K M2 L7–8 Level K M4 L1–2, 6–7, 10, 14–17, 20–24, 26–28
Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.	Level K M3 L4–8, 14–20, 22–26 Level K M4 L25
Compare predictions (based on prior experiences) to what occurred (observable events).	Level K M4 L14–16
Analyze data from tests of an object or tool to determine if it works as intended.†	Level K M4 L20–24

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide when to use qualitative vs. quantitative data.	Level K M2 L17–20
Use counting and numbers to identify and describe patterns in the natural and designed world(s).	Level K M1 L17–21, 25–30 Level K M2 L17–20
Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.	Level 2 M1 L20–22 Level 2 M3 L8–11, 23–29 Level 2 M4 L17–19
Use quantitative data to compare two alternative solutions to a problem.	Level 1 M3 L21–25 Level 2 M2 L14–17

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	Level K M3 L4–16, 23–29
Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem.†	Level K M2 L17–20
Generate and/or compare multiple solutions to a problem.	Level 1 M3 L21–25 Level 2 M2 L8–12, 14–17

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Identify arguments that are supported by evidence.	Level K M3 L17–18
Distinguish between explanations that account for all gathered evidence and those that do not.	Level 1 M3 L4–6 Level 1 M4 L14–18
Analyze why some evidence is relevant to a scientific question and some is not.	Level K M4 L25
Distinguish between opinions and evidence in one's own explanations.	Level K M3 L17–18
Listen actively to arguments to indicate agreement or disagreement based on evidence and/or to retell the main points of the argument.	Level K M3 L17–20 Level K M4 L3–5, 11–13
Construct an argument with evidence to support a claim.†	Level K M3 L17–21, 27–29
Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	Level 1 M3 L8–9, 18–20 Level 2 M3 L14–18, 21–22

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world.†	Level K M4 L1–2, 6–10, 14–16, 18–19
Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.	Level 1 M4 L14–18, 23–25 Level 2 M3 L14–18
Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.	Level K M3 L23–26
Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas.†	Level K M1 L12–16, 28–30 Level K M2 L21–23 Level K M3 L27–29 Level K M4 L20–24, 26–28

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Disciplinary Core Ideas

Physical Science

PS2.A	**Forces and Motion**	**Aligned *PhD Science* Lessons**
	Pushes and pulls can have different strengths and directions.	Level K M2 L7–23
	Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.	Level K M2 L1–23
PS2.B	**Types of Interactions**	**Aligned *PhD Science* Lessons**
	When objects touch or collide, they push on one another and can change motion.	Level K M2 L13–23
PS3.B	**Conservation of Energy and Energy Transfer**	**Aligned *PhD Science* Lessons**
	Sunlight warms Earth's surface.	Level K M1 L8–16, 28–30
PS3.C	**Relationship Between Energy and Forces**	**Aligned *PhD Science* Lessons**
	A bigger push or pull makes things speed up or slow down more quickly.	Level K M2 L7–9, 21–23

Life Science

LS1.C	**Organization for Matter and Energy Flow in Organisms**	**Aligned *PhD Science* Lessons**
	All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	Level K M3 L4–16, 19–20, 22, 27–29

Earth and Space Science

ESS2.D	**Weather and Climate**	**Aligned *PhD Science* Lessons**
	Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	Level K M1 L1–11, 17–24, 28–30 Level K M4 L25
ESS2.E	**Biogeology**	**Aligned *PhD Science* Lessons**
	Plants and animals can change their environment.	Level K M4 L1–10, 14–16, 26–28
ESS3.A	**Natural Resources**	**Aligned *PhD Science* Lessons**
	Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.	Level K M3 L1–3, 9–29 Level K M4 L1–5, 8–9, 11–16
ESS3.B	**Natural Hazards**	**Aligned *PhD Science* Lessons**
	Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events.	Level K M1 L17–20, 22–30
ESS3.C	**Human Impacts on Earth Systems**	**Aligned *PhD Science* Lessons**
	Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.	Level K M4 L11–24, 26–28

Engineering, Technology, and Applications of Science

ETS1.A	Defining and Delimiting Engineering Problems	Aligned *PhD Science* Lessons
	A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.	Level K M1 L4–7, 12–16 Level K M2 L17–20
	Asking questions, making observations, and gathering information are helpful in thinking about problems.	Level K M1 L12–16
	Before beginning to design a solution, it is important to clearly understand the problem.	Level K M1 L12–16
ETS1.B	**Developing Possible Solutions**	**Aligned *PhD Science* Lessons**
	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	Level K M2 L17–20 Level K M4 L20–24
ETS1.C	**Optimizing the Design Solution**	**Aligned *PhD Science* Lessons**
	Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	Level K M4 L20–24

Crosscutting Concepts

Patterns	Aligned *PhD Science* Lessons
Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.†	Level K M1 L17–30 Level K M2 L1–6, 17–20 Level K M3 L4–8, 14–20, 22, 26–29 Level K M4 L3–5

Cause and Effect	Aligned *PhD Science* Lessons
Events have causes that generate observable patterns.†	Level K M2 L4–16, 21–23 Level K M4 L3–5, 10, 14–19, 26–28
Simple tests can be designed to gather evidence to support or refute student ideas about causes.†	Level K M2 L10–12, 17–20

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Scale, Proportion, and Quantity	Aligned *PhD Science* Lessons
Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).	Level K M1 L1–7, 10–24, 28–30 Level K M2 L7–9, 13–15, 21–23 Level K M3 L1–3 Level K M4 L25
Standard units are used to measure length.	Level 2 M3 L3–6, 14–18, 25–29

Systems and System Models	Aligned *PhD Science* Lessons
Objects and organisms can be described in terms of their parts.	Level 1 M1 L1–6, 16–17 Level 1 M3 L1–3, 8–10, 14, 21–29 Level 2 M1 L1–7, 12–13, 20–23, 29–31 Level 2 M2 L3–4, 7 Level 2 M3 L8–13, 19–24
Systems in the natural and designed world have parts that work together.†	Level K M3 L1–3, 9–13, 19–21, 23–25, 27–29 Level K M4 L1–9, 11–16

Energy and Matter	Aligned *PhD Science* Lessons
Objects may break into smaller pieces, be put together into larger pieces, or change shapes.	Level 2 M1 L10–11, 29–31 Level 2 M2 L3–4, 8–13, 22–24

Structure and Function	Aligned *PhD Science* Lessons
The shape and stability of structures of natural and designed objects are related to their function(s).†	Level K M1 L10–16 Level K M4 L20–24

Stability and Change	Aligned *PhD Science* Lessons
Some things stay the same while other things change.	Level K M1 L8–9, 17–21
Things may change slowly or rapidly.	Level K M4 L14–16

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

PhD Science® K–2 Curriculum Correlation to *Kentucky Academic Standards for Science*: Level 1

The *PhD Science* Level 1 curriculum fully aligns with the First Grade *Kentucky Academic Standards for Science*. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

First Grade

Performance Expectations: Physical Science		**Aligned *PhD Science* Lessons**
1-PS4-1	Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.	Level 1 M3 L1–17, 26–29
1-PS4-2	Make observations to construct an evidence-based account that objects can be seen only when illuminated.	Level 1 M2 L1–9, 21–23
1-PS4-3	Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.	Level 1 M2 L1–3, 10–23
1-PS4-4	Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.	Level 1 M3 L18–29

Performance Expectations: Life Science		**Aligned *PhD Science* Lessons**
1-LS1-1	Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.	Level 1 M1 L1–21, 27–29
1-LS1-2	Read texts and use media to determine patterns in the behavior of parents and offspring that help offspring survive.	Level 1 M1 L24–29
1-LS3-1	Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.	Level 1 M1 L22–23, 26–29

Performance Expectations: Earth and Space Science		**Aligned *PhD Science* Lessons**
1-ESS1-1	Use observations of the sun, moon, and stars to describe patterns that can be predicted.	Level 1 M4 L1–8, 14–25
1-ESS1-2	Make observations at different times of year to relate the amount of daylight to the time of year.	Level 1 M4 L9–13, 23–25

K–2 Engineering Design

Performance Expectations: Engineering, Technology, and Applications of Science		Aligned *PhD Science* Lessons
K–2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	Level 1 M1 L11–15
K–2-ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	Level 1 M3 L21–25
K–2-ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	Level 1 M3 L21–25

Science and Engineering Practices

Asking Questions and Defining Problems	Aligned *PhD Science* Lessons
Ask questions based on observations to find more information about the natural and/or designed world(s).†	Level 1 M1 L1–3 Level 1 M2 L1–3 Level 1 M3 L1–3 Level 1 M4 L1–3, 14–16
Ask and/or identify questions that can be answered by an investigation.	Level K M1 L8–9 Level K M3 L4–8, 22 Level 2 M3 L3–6
Define a simple problem that can be solved through the development of a new or improved object or tool.†	Level 1 M1 L11–15

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Developing and Using Models	Aligned *PhD Science* Lessons
Distinguish between a model and the actual object, process, and/or events the model represents.	Level 1 M1 L4–9, 18 Level 1 M3 L14
Compare models to identify common features and differences.	Level 1 M1 L11–15 Level 1 M2 L1–3
Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	Level 1 M1 L1–8 Level 1 M2 L1–7, 10–23 Level 1 M3 L7, 11–13 Level 1 M4 L1–3, 7–8
Develop a simple model based on evidence to represent a proposed object or tool.	Level 1 M1 L11–15

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
Plan and conduct investigations collaboratively in order to produce data to serve as the basis for evidence to answer a question.†	Level 1 M1 L19–20 Level 1 M2 L15–18
Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.	Level K M4 L3–5 Level 2 M2 L3–4, 8–12, 22–24
Make observations (firsthand or from media) to collect data that can be used to make comparisons.†	Level 1 M2 L4–12, 15–18, 20–23 Level 1 M3 L1–7, 11–13, 18–19 Level 1 M4 L4–6, 14–16, 19–21
Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.	Level 1 M3 L8–9, 20–25
Make predictions based on prior experiences.	Level 1 M3 L11–13, 15–17, 26–29 Level 1 M4 L1–3

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Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Record information (observations, thoughts, and ideas).	Level 1 M1 L10
Use and share pictures, drawings, and/or writings of observations.	Level K M2 L7–8 Level K M4 L1–2, 6–7, 10, 14–17, 20–24, 26–28
Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.†	Level 1 M1 L16–21, 27–29 Level 1 M2 L1–9 Level 1 M3 L10 Level 1 M4 L4–6, 9–13
Compare predictions (based on prior experiences) to what occurred (observable events).	Level 1 M3 L11–13, 15–16, 26–29
Analyze data from tests of an object or tool to determine if it works as intended.†	Level 1 M3 L8–9

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide when to use qualitative vs. quantitative data.	Level 1 M2 L15–18
Use counting and numbers to identify and describe patterns in the natural and designed world(s).	Level K M1 L17–21, 25–30 Level K M2 L17–20 Level 2 M4 L7–8, 20–22
Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.	Level 2 M1 L20–22 Level 2 M3 L8–11, 23–29 Level 2 M4 L17–19
Use quantitative data to compare two alternative solutions to a problem.	Level 1 M3 L21–25

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.†	Level 1 M1 L7–8, 16–17, 22–23, 26–29 Level 1 M2 L4–7, 21–23 Level 1 M3 L4–6, 14, 26–29
Use tools and materials provided to design a device that solves a specific problem or a solution to a specific problem.†	Level 1 M1 L11–15
Generate and/or compare multiple solutions to a problem.	Level 1 M3 L21–25

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Identify arguments that are supported by evidence.	Level 1 M4 L4–8, 23–25
Distinguish between explanations that account for all gathered evidence and those that do not.	Level 1 M3 L4–6 Level 1 M4 L14–18
Analyze why some evidence is relevant to a scientific question and some is not.	Level 1 M4 L19–25
Distinguish between opinions and evidence in one's own explanations.	Level 1 M4 L9–13
Listen actively to arguments to indicate agreement or disagreement based on evidence and/or to retell the main points of the argument.	Level K M3 L17–20 Level K M4 L3–5, 11–13 Level 2 M2 L20 Level 2 M4 L4–6, 9–13, 23–25
Construct an argument with evidence to support a claim.	Level 1 M4 L9–13, 19–21
Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	Level 1 M3 L8–9, 18–20

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world.†	Level 1 M1 L24–25 Level 1 M3 L18–19 Level 1 M4 L9–13
Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.	Level 1 M4 L14–18, 23–25
Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question and/or supporting a scientific claim.	Level K M3 L23–26 Level 2 M2 L5–6, 18–19 Level 2 M4 L4–9, 11–16, 23–25
Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.	Level 1 M1 L27–29 Level 1 M2 L21–23 Level 1 M3 L26–29 Level 1 M4 L23–25

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Disciplinary Core Ideas

Physical Science

PS4.A	**Wave Properties**	**Aligned *PhD Science* Lessons**
	Sound can make matter vibrate, and vibrating matter can make sound.	Level 1 M3 L1–17, 26–29
PS4.B	**Electromagnetic Radiation**	**Aligned *PhD Science* Lessons**
	Objects can be seen if light is available to illuminate them or if they give off their own light.	Level 1 M2 L1–9, 21–23
	Some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam.	Level 1 M2 L1–3, 10–23
PS4.C	**Information Technologies and Instrumentation**	**Aligned *PhD Science* Lessons**
	People also use a variety of devices to communicate (send and receive information) over long distances.	Level 1 M3 L18–29

Life Science

LS1.A	**Structure and Function**	**Aligned *PhD Science* Lessons**
	All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.	Level 1 M1 L1–15, 27–29
LS1.B	**Growth and Development of Organisms**	**Aligned *PhD Science* Lessons**
	Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.	Level 1 M1 L24–29
LS1.D	**Information Processing**	**Aligned *PhD Science* Lessons**
	Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs.	Level 1 M1 L16–21, 27–29

LS3.A	Inheritance of Traits	Aligned *PhD Science* Lessons
	Young animals are very much but not exactly like their parents. Plants also are very much but not exactly like their parents.	Level 1 M1 L22–23, 26–29
LS3.B	**Variation of Traits**	**Aligned *PhD Science* Lessons**
	Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.	Level 1 M1 L22–23, 27–29

Earth and Space Science

ESS1.A	The Universe and Its Stars	Aligned *PhD Science* Lessons
	Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.	Level 1 M4 L1–8, 14–25
ESS1.B	**Earth and the Solar System**	**Aligned *PhD Science* Lessons**
	Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	Level 1 M4 L9–13, 23–25

Engineering, Technology, and Applications of Science

ETS1.A	Defining and Delimiting Engineering Problems	Aligned *PhD Science* Lessons
	A situation that people want to change or create can be approached as a problem to be solved through engineering.	Level 1 M1 L11–15
	Asking questions, making observations, and gathering information are helpful in thinking about problems.	Level 1 M1 L11–15
	Before beginning to design a solution, it is important to clearly understand the problem.	Level 1 M1 L11–15
ETS1.B	**Developing Possible Solutions**	**Aligned *PhD Science* Lessons**
	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	Level 1 M3 L21–25
ETS1.C	**Optimizing the Design Solution**	**Aligned *PhD Science* Lessons**
	Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	Level 1 M3 L21–25

Crosscutting Concepts

Patterns	**Aligned *PhD Science* Lessons**
Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.†	Level 1 M1 L1–6, 16–29 Level 1 M2 L1–9, 21–23 Level 1 M3 L1–7, 11–13, 17–20, 26–29 Level 1 M4 L1–25

Cause and Effect	**Aligned *PhD Science* Lessons**
Events have causes that generate observable patterns.	Level 1 M2 L1–7, 10–12, 15–23 Level 1 M3 L4–6, 14, 17, 26–29 Level 1 M4 L4–6, 9–13, 17–21, 23–25
Simple tests can be designed to gather evidence to support or refute student ideas about causes.†	Level 1 M2 L13–14 Level 1 M3 L7, 15–16

Scale, Proportion, and Quantity	**Aligned *PhD Science* Lessons**
Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).	Level K M1 L1–7, 10–24, 28–30 Level K M2 L7–9, 13–15, 21–23 Level K M3 L1–3 Level K M4 L25 Level 2 M1 L8–9 Level 2 M2 L18–21 Level 2 M3 L25–29 Level 2 M4 L1–6, 17–19, 22–25
Standard units are used to measure length.	Level 2 M3 L3–6, 14–18, 25–29

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Systems and System Models	Aligned *PhD Science* Lessons
Objects and organisms can be described in terms of their parts.	Level 1 M1 L1–6, 16–17 Level 1 M3 L1–3, 8–10, 14, 21–29
Systems in the natural and designed world have parts that work together.	Level 1 M1 L7–8 Level 1 M2 L1–3, 10–23 Level 1 M3 L21–25

Energy and Matter	Aligned *PhD Science* Lessons
Objects may break into smaller pieces, be put together into larger pieces, or change shapes.	Level 2 M1 L10–11, 29–31 Level 2 M2 L3–4, 8–13, 22–24

Structure and Function	Aligned *PhD Science* Lessons
The shape and stability of structures of natural and designed objects are related to their function(s).†	Level 1 M1 L4–15, 27–29 Level 1 M3 L8–9

Stability and Change	Aligned *PhD Science* Lessons
Some things stay the same while other things change.	Level K M1 L8–9, 17–21 Level 2 M2 L1–2, 22–24 Level 2 M3 L1–2, 25–29
Things may change slowly or rapidly.	Level K M4 L14–16 Level 2 M2 L18–24

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

PhD Science® K–2 Curriculum Correlation to *Kentucky Academic Standards for Science*: Level 2

The *PhD Science* Level 2 curriculum fully aligns with the Second Grade *Kentucky Academic Standards for Science*. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Second Grade

Performance Expectations: Physical Science		**Aligned *PhD Science* Lessons**
2-PS1-1	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.	Level 2 M1 L1–9, 12–16, 19, 23, 29–31 Level 2 M2 L3–4, 14–17
2-PS1-2	Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.	Level 2 M1 L20–31
2-PS1-3	Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.	Level 2 M1 L10–11, 29–31
2-PS1-4	Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.	Level 2 M1 L14–19, 29–31

Performance Expectations: Life Science		**Aligned *PhD Science* Lessons**
2-LS2-1	Plan and conduct an investigation to determine if plants need sunlight and water to grow.	Level 2 M3 L1–7, 25–29
2-LS2-2	Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.	Level 2 M3 L8–29
2-LS4-1	Make observations of plants and animals to compare the diversity of life in different habitats.	Level 2 M4 L1–3, 7–25

Performance Expectations: Earth and Space Science		Aligned *PhD Science* Lessons
2-ESS1-1	Use information from several sources to provide evidence that Earth events can occur quickly or slowly.	Level 2 M2 L18–24
2-ESS2-1	Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.	Level 2 M2 L1–17, 20, 22–24
2-ESS2-2	Develop a model to represent the shapes and kinds of land and bodies of water in an area.	Level 2 M2 L1–2, 5–6 Level 2 M4 L1–6, 11–16, 20–21, 23–25
2-ESS2-3	Obtain information to identify where water is found on Earth and that it can be solid or liquid.	Level 2 M4 L1–6, 16, 22–25

K–2 Engineering Design

Performance Expectations: Engineering, Technology, and Applications of Science		Aligned *PhD Science* Lessons
K–2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	Level 2 M1 L24–28 Level 2 M2 L8–12
K–2-ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	Level 2 M3 L14–18
K–2-ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	Level 2 M2 L8–12, 14–17

Science and Engineering Practices

Asking Questions and Defining Problems	Aligned PhD Science Lessons
Ask questions based on observations to find more information about the natural and/or designed world(s).†	Level 2 M1 L1–3 Level 2 M2 L1–2 Level 2 M3 L1–2 Level 2 M4 L1–3
Ask and/or identify questions that can be answered by an investigation.	Level 2 M3 L3–6
Define a simple problem that can be solved through the development of a new or improved object or tool.†	Level 2 M3 L14–18

Developing and Using Models	Aligned PhD Science Lessons
Distinguish between a model and the actual object, process, and/or events the model represents.	Level 2 M4 L4–6
Compare models to identify common features and differences.	Level 2 M4 L1–6, 20–21, 23–25
Develop a model to represent patterns in the natural world.†	Level 2 M1 L1–3, 14–16, 19, 29–31 Level 2 M2 L1–2, 14–17, 20–24 Level 2 M3 L1–6, 8–12, 19–20, 23–29 Level 2 M4 L1–3, 7–8
Develop a simple model based on evidence to represent a proposed object or tool.†	Level 2 M3 L14–18

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Planning and Carrying Out Investigations	Aligned PhD Science Lessons
Plan and conduct an investigation collaboratively in order to produce data to serve as the basis for evidence to answer a question.†	Level 2 M2 L8–12 Level 2 M3 L3–7 Level 2 M4 L17–19
Evaluate different ways of observing and/or measuring a phenomenon to determine which way can answer a question.	Level 2 M2 L3–4, 8–12, 22–24
Make observations (firsthand or from media) to collect data that can be used to make comparisons.†	Level 2 M1 L1–3, 29–31 Level 2 M2 L1–6, 14–19 Level 2 M3 L3–6, 8–11, 13, 21–22, 25–29 Level 2 M4 L16–19
Make observations (firsthand or from media) and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.	Level 2 M1 L20–22, 24–28 Level 2 M2 L14–17
Make predictions based on prior experiences.	Level 2 M1 L17–18

Analyzing and Interpreting Data	Aligned PhD Science Lessons
Record information (observations, thoughts, and ideas).	Level 2 M1 L4–7, 10–11, 14–18
Use and share pictures, drawings, and/or writings of observations.	Level K M2 L7–8 Level K M4 L1–2, 6–7, 10, 14–17, 20–24, 26–28
Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.	Level 2 M1 L4–11 Level 2 M2 L5–6, 8–9 Level 2 M3 L19–20 Level 2 M4 L22–25
Compare predictions (based on prior experiences) to what occurred (observable events).	Level K M4 L14–16 Level 1 M3 L11–13, 15–16, 26–29
Analyze data from tests of an object or tool to determine if it works as intended.†	Level 2 M1 L20–22, 24–28 Level 2 M3 L14–18

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Using Mathematics and Computational Thinking	Aligned PhD Science Lessons
Decide when to use qualitative vs. quantitative data.	Level K M2 L17–20 Level 1 M2 L15–18
Use counting and numbers to identify and describe patterns in the natural and designed world(s).	Level 2 M4 L7–8, 20–22
Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.	Level 2 M1 L20–22 Level 2 M3 L8–11, 23–29 Level 2 M4 L17–19
Use quantitative data to compare two alternative solutions to a problem.	Level 2 M2 L14–17

Constructing Explanations and Designing Solutions	Aligned PhD Science Lessons
Make observations from several sources (firsthand or from media) to construct an evidence-based account for natural phenomena.†	Level 2 M1 L8–9, 12–13, 17–19, 23, 29–31 Level 2 M2 L3–4, 7, 13, 22–24 Level 2 M4 L23–25
Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.	Level 2 M1 L24–28
Compare multiple solutions to a problem.†	Level 2 M2 L8–12, 14–17

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Engaging in Argument from Evidence	Aligned PhD Science Lessons
Identify arguments that are supported by evidence.	Level K M3 L17–18 Level 1 M4 L4–8, 23–25
Distinguish between explanations that account for all gathered evidence and those that do not.	Level 1 M3 L4–6 Level 1 M4 L14–18
Analyze why some evidence is relevant to a scientific question and some is not.	Level 2 M4 L20–21
Distinguish between opinions and evidence in one's own explanations.	Level K M3 L17–18 Level 1 M4 L9–13
Listen actively to arguments to indicate agreement or disagreement based on evidence and/or to retell the main points of the argument.	Level 2 M2 L20 Level 2 M4 L4–6, 9–13, 23–25
Construct an argument with evidence to support a claim.†	Level 2 M2 L3–4, 10–13, 21–24 Level 2 M4 L16
Make a claim about the effectiveness of an object, tool, or solution that is supported by relevant evidence.	Level 2 M3 L14–18, 21–22

Obtaining, Evaluating, and Communicating Information	Aligned PhD Science Lessons
Read grade-appropriate texts and/or use media to obtain scientific and/or technical information to determine patterns in and/or evidence about the natural and designed world(s).	Level 2 M2 L1–2, 14–17
Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.	Level 2 M3 L14–18
Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question.†	Level 2 M2 L5–6, 18–19 Level 2 M4 L4–9, 11–16, 23–25
Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.	Level 2 M1 L29–31 Level 2 M2 L22–24 Level 2 M3 L8–12, 14–20, 25–29 Level 2 M4 L23–25

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Disciplinary Core Ideas

Physical Science

PS1.A	**Structure and Properties of Matter**	**Aligned *PhD Science* Lessons**
	Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.	Level 2 M1 L1–16, 19, 23, 29–31 Level 2 M2 L3–4, 14–17
	Different properties are suited to different purposes.	Level 2 M1 L20–31
	A great variety of objects can be built up from a small set of pieces.	Level 2 M1 L10–11, 24–31
PS1.B	**Chemical Reactions**	**Aligned *PhD Science* Lessons**
	Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.	Level 2 M1 L14–19, 29–31

Life Science

LS2.A	**Interdependent Relationships in Ecosystems**	**Aligned *PhD Science* Lessons**
	Plants depend on water and light to grow.	Level 2 M3 L1–7, 25–29
	Plants depend on animals for pollination or to move their seeds around.	Level 2 M3 L8–29
LS4.D	**Biodiversity and Humans**	**Aligned *PhD Science* Lessons**
	There are many different kinds of living things in any area, and they exist in different places on land and in water.	Level 2 M4 L1–3, 7–25

Earth and Space Science

ESS1.C	**The History of Planet Earth**	**Aligned *PhD Science* Lessons**
	Some events happen very quickly; others occur very slowly over a time period much longer than one can observe.	Level 2 M2 L18–24
ESS2.A	**Earth Materials and Systems**	**Aligned *PhD Science* Lessons**
	Wind and water can change the shape of the land.	Level 2 M2 L1–17, 20, 22–24
ESS2.B	**Plate Tectonics and Large-Scale System Interactions**	**Aligned *PhD Science* Lessons**
	Maps show where things are located. One can map the shapes and kinds of land and water in any area.	Level 2 M2 L1–2, 5–6 Level 2 M4 L1–6, 11–16, 20–21, 23–25
ESS2.C	**The Roles of Water in Earth's Surface Processes**	**Aligned *PhD Science* Lessons**
	Water is found in the oceans, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.	Level 2 M4 L1–6, 16, 22–25

Engineering, Technology, and Applications of Science

ETS1.A	**Defining and Delimiting Engineering Problems**	**Aligned *PhD Science* Lessons**
	A situation that people want to change or create can be approached as a problem to be solved through engineering.	Level 2 M1 L24–28 Level 2 M2 L8–12
	Asking questions, making observations, and gathering information are helpful in thinking about problems.	Level 2 M1 L24–28
	Before beginning to design a solution, it is important to clearly understand the problem.	Level 2 M1 L24–28
ETS1.B	**Developing Possible Solutions**	**Aligned *PhD Science* Lessons**
	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	Level 2 M3 L14–18
ETS1.C	**Optimizing the Design Solution**	**Aligned *PhD Science* Lessons**
	Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	Level 2 M2 L8–12, 14–17

Crosscutting Concepts

Patterns	**Aligned *PhD Science* Lessons**
Patterns in the natural and human-designed world can be observed.†	Level 2 M1 L4–9 Level 2 M2 L1–2, 5–6 Level 2 M4 L1–8, 11–15, 20–21, 23–25

Cause and Effect	**Aligned *PhD Science* Lessons**
Events have causes that generate observable patterns.†	Level 2 M1 L14–19, 29–31 Level 2 M2 L20–21 Level 2 M3 L8–11
Simple tests can be designed to gather evidence to support or refute student ideas about causes.†	Level 2 M1 L14–18 Level 2 M2 L8–12 Level 2 M3 L3–7

Scale, Proportion, and Quantity	**Aligned *PhD Science* Lessons**
Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).	Level 2 M1 L8–9 Level 2 M2 L18–21 Level 2 M3 L25–29 Level 2 M4 L1–6, 17–19, 22–25
Standard units are used to measure length.	Level 2 M3 L3–6, 14–18, 25–29

Systems and System Models	**Aligned *PhD Science* Lessons**
Objects and organisms can be described in terms of their parts.	Level 2 M1 L1–7, 12–13, 20–23, 29–31 Level 2 M2 L3–4, 7 Level 2 M3 L8–13, 19–24
Systems in the natural and designed world have parts that work together.	Level 2 M2 L8–12, 14–17 Level 2 M4 L7–16, 23–25

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Energy and Matter	Aligned *PhD Science* Lessons
Objects may break into smaller pieces and be put together into larger pieces, or they may change shape.†	Level 2 M1 L10–11, 29–31 Level 2 M2 L3–4, 8–13, 22–24

Structure and Function	Aligned *PhD Science* Lessons
The shape and stability of structures of natural and designed objects are related to their function(s).	Level 2 M1 L24–28 Level 2 M2 L14–17 Level 2 M3 L8–11, 14–22

Stability and Change	Aligned *PhD Science* Lessons
Some things stay the same while other things change.	Level 2 M2 L1–2, 22–24 Level 2 M3 L1–2, 25–29
Things may change slowly or rapidly.†	Level 2 M2 L18–24

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

PhD Science® 3–5 Curriculum Correlation to *Kentucky Academic Standards for Science*: Level 3

The *PhD Science* Level 3 curriculum fully aligns with the Third Grade *Kentucky Academic Standards for Science*. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Third Grade

Performance Expectations: Physical Science		**Aligned *PhD Science* Lessons**
3-PS2-1	Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.	Level 3 M4 L10–18, 28–30
3-PS2-2	Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	Level 3 M4 L1–9, 28–30
3-PS2-3	Ask questions to determine cause-and-effect relationships of electric or magnetic interactions between two objects not in contact with each other.	Level 3 M4 L19–21, 28–30
3-PS2-4	Define a simple design problem that can be solved by applying scientific ideas about magnets.	Level 3 M4 L22–30

Performance Expectations: Life Science		Aligned *PhD Science* Lessons
3-LS1-1	Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	Level 3 M3 L7–8, 23–28
3-LS2-1	Construct an argument that some animals form groups that help members survive.	Level 3 M2 L13–15, 26–28
3-LS3-1	Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.	Level 3 M3 L1–6, 14–18, 26–28
3-LS3-2	Use evidence to support the explanation that traits can be influenced by the environment.	Level 3 M3 L9–13, 19–20, 26–28
3-LS4-2	Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.	Level 3 M3 L21–28
3-LS4-3	Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	Level 3 M2 L1–2, 9–12, 16–19, 22–28
3-LS4-4	Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.	Level 3 M2 L16–28

Performance Expectations: Earth and Space Science		Aligned *PhD Science* Lessons
3-ESS2-1	Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.	Level 3 M1 L1–15, 19–20, 27–29
3-ESS2-2	Obtain and combine information to describe climates in different regions of the world.	Level 3 M1 L11–15, 27–29
3-ESS3-1	Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.	Level 3 M1 L1–3, 16–29

3–5 Engineering Design

Performance Expectations: Engineering, Technology, and Applications of Science		Aligned *PhD Science* Lessons
3–5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	Level 3 M1 L21–26
3–5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	Level 3 M2 L22–25
3–5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	Level 3 M4 L23–27

Science and Engineering Practices

Asking Questions and Defining Problems	Aligned *PhD Science* Lessons
Ask questions about what would happen if a variable is changed.	Level 4 M3 L15–19
Identify scientific (testable) and non-scientific (non-testable) questions.	Level 3 M3 L12–13 Level 3 M4 L15–16, 19–21
Ask questions that can be investigated based on patterns, such as cause-and-effect relationships.†	Level 3 M1 L1–3 Level 3 M2 L1–2 Level 3 M3 L1–3 Level 3 M4 L1–3, 7–9, 28–30
Use prior knowledge to describe problems that can be solved.	Level 3 M4 L22, 29–30
Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.†	Level 3 M1 L21–26, 28–29 Level 3 M4 L23–27

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Developing and Using Models	Aligned *PhD Science* Lessons
Identify limitations of models.	Level 4 M4 L14–17, 26–27 Level 5 M1 L5–6 Level 5 M2 L14 Level 5 M3 L6–8, 25–27
Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.	Level 4 M2 L15–16 Level 4 M4 L3–8, 10–13 Level 5 M1 L5–6 Level 5 M2 L1–2, 6–7 Level 5 M4 L1–2, 7–8, 14–17
Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.	Level 3 M1 L1–3 Level 3 M2 L1–3, 6–8, 27–28
Develop models to describe phenomena.†	Level 3 M1 L1–3, 19–20 Level 3 M2 L9–12, 27–28 Level 3 M3 L7–11, 21–25, 27–28 Level 3 M4 L1–3, 17–18, 28–30
Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	Level 3 M2 L22–25 Level 3 M4 L23–27
Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Level 4 M3 L7–11 Level 4 M4 L10–13, 18–24 Level 5 M3 L12–13 Level 5 M4 L9–12

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
Plan and conduct an investigation collaboratively in order to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials is considered.†	Level 3 M4 L7–9, 15–16, 23–27, 29–30
Evaluate appropriate methods and/or tools for collecting data.	Level 3 M3 L12–13
Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.†	Level 3 M2 L4–5 Level 3 M4 L7–18, 29–30
Make predictions about what would happen if a variable changes.	Level 3 M3 L12–13 Level 3 M4 L7–9, 15–16, 28–30
Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	Level 4 M4 L14–17

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Represent data in tables or various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.†	Level 3 M1 L4–12 Level 3 M3 L7–8, 27–28 Level 3 M4 L4–9
Analyze and interpret data to make sense of phenomena, using logical reasoning.†	Level 3 M1 L11–15, 19–20, 27–29 Level 3 M2 L3–8, 16–19, 27–28 Level 3 M3 L4–6, 14–18, 27–28
Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.	Level 3 M3 L14–15, 19–20 Level 3 M4 L7–9
Analyze data to refine a problem statement or the design of a proposed object, tool, or process.	Level 4 M4 L14–17
Use data to evaluate and refine design solutions.	Level 4 M4 L14–17

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.	Level 3 M4 L23–27
Organize simple data sets to reveal patterns that suggest relationships.	Level 3 M1 L4–12 Level 3 M2 L3, 16–19 Level 3 M3 L7–8
Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.	Level 3 M3 L7–8
Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.	Level 4 M4 L14–17

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard).	Level 3 M2 L6–8 Level 3 M3 L26–28 Level 3 M4 L10–14
Use evidence (e.g., observations, patterns) to construct or support an explanation.†	Level 3 M1 L13–15, 18 Level 3 M2 L6–8, 26–28 Level 3 M3 L9–11, 14–15, 21–28 Level 3 M4 L10–14, 19–21, 28–30
Identify the evidence that supports particular points in an explanation.	Level 3 M2 L26–28 Level 3 M3 L26–28 Level 3 M4 L28–30
Apply scientific ideas to solve design problems.	Level 3 M2 L22–25 Level 3 M4 L28–30
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.†	Level 3 M1 L21–29 Level 3 M2 L22–25

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Compare and refine arguments based on an evaluation of the evidence presented.	Level 3 M3 L16–18
Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.	Level 5 M4 L5–6
Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.	Level 4 M3 L21–23 Level 5 M2 L3–5, 21–23, 25–26
Construct an argument with evidence, data, and/or a model.†	Level 3 M2 L9–15, 27–28 Level 3 M3 L16–18
Use data to evaluate claims about cause and effect.	Level 3 M3 L19–20 Level 3 M4 L12–14
Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.†	Level 3 M1 L21–26, 28–29 Level 3 M2 L20–21

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.	Level 3 M2 L13–15 Level 3 M4 L22
Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.	Level 3 M2 L13–15
Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.	Level 5 M4 L18–19
Obtain and combine information from books and other reliable media to explain phenomena.†	Level 3 M1 L11–17, 28–29
Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Level 3 M2 L20–21

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Disciplinary Core Ideas

Physical Science

PS2.A	**Forces and Motion**	**Aligned *PhD Science* Lessons**
	Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.	Level 3 M4 L10–18, 28–30
	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.	Level 3 M4 L1–9, 28–30
PS2.B	**Types of Interactions**	**Aligned *PhD Science* Lessons**
	Objects in contact exert forces on each other.	Level 3 M4 L10–18, 28–30
	Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	Level 3 M4 L19–30

Life Science

LS1.B	**Growth and Development of Organisms**	**Aligned *PhD Science* Lessons**
	Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	Level 3 M3 L7–8, 23–28
LS2.C	**Ecosystem Dynamics, Functioning, and Resilience**	**Aligned *PhD Science* Lessons**
	When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.	Level 3 M2 L16–28
LS2.D	**Social Interactions and Group Behavior**	**Aligned *PhD Science* Lessons**
	Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size.	Level 3 M2 L13–15, 26–28

LS3.A	**Inheritance of Traits**	**Aligned *PhD Science* Lessons**
	Many characteristics of organisms are inherited from their parents.	Level 3 M3 L14–18, 26–28
	Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.	Level 3 M3 L9–13, 19–20, 26–28
LS3.B	**Variation of Traits**	**Aligned *PhD Science* Lessons**
	Different organisms vary in how they look and function because they have different inherited information.	Level 3 M3 L1–6, 14–18, 23–28
	The environment also affects the traits that an organism develops.	Level 3 M3 L9–13, 19–20
LS4.B	**Natural Selection**	**Aligned *PhD Science* Lessons**
	Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.	Level 3 M3 L21–28
LS4.C	**Adaptation**	**Aligned *PhD Science* Lessons**
	For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Level 3 M2 L1–2, 9–12, 16–19, 22–28
LS4.D	**Biodiversity and Humans**	**Aligned *PhD Science* Lessons**
	Populations live in a variety of habitats, and changes in those habitats affect the organisms living there.	Level 3 M2 L16–28

Earth and Space Science

ESS2.D	**Weather and Climate**	**Aligned *PhD Science* Lessons**
	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.	Level 3 M1 L1–15, 19–20, 27–29
	Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.	Level 3 M1 L11–15, 27–29
ESS3.B	**Natural Hazards**	**Aligned *PhD Science* Lessons**
	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.	Level 3 M1 L1–3, 16–29

Engineering, Technology, and Applications of Science

ETS1.A	Defining and Delimiting Engineering Problems	Aligned *PhD Science* Lessons
	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	Level 3 M1 L21–26
ETS1.B	**Developing Possible Solutions**	**Aligned *PhD Science* Lessons**
	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.	Level 3 M1 L22–23
	At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	Level 3 M2 L22–25
	Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	Level 3 M4 L23–27
ETS1.C	**Optimizing the Design Solution**	**Aligned *PhD Science* Lessons**
	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	Level 3 M4 L23–27

Crosscutting Concepts

Patterns	Aligned *PhD Science* Lessons
Similarities and differences in patterns can be used to sort and classify natural phenomena.†	Level 3 M3 L1–8, 14–15, 27–28 Level 3 M4 L29–30
Patterns of change can be used to make predictions.†	Level 3 M1 L11–15, 19–20, 27–29 Level 3 M3 L7–8 Level 3 M4 L1–9, 28–30
Patterns can be used as evidence to support an explanation.	Level 3 M1 L11–15, 28–29 Level 3 M2 L3–8, 13–15, 27–28 Level 3 M3 L16–18, 26–28

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Cause and Effect	Aligned *PhD Science* Lessons
Cause-and-effect relationships are routinely identified, tested, and used to explain change.†	Level 3 M1 L16–18, 21–26, 28–29 Level 3 M2 L9–12, 16–28 Level 3 M3 L9–13, 19–25, 27–28 Level 3 M4 L1–3, 10–30
Identify and test causal relationships and use these relationships to explain change.†	
Events that occur together with regularity might or might not be a cause and effect relationship.	Level 3 M1 L1–3, 27–29 Level 3 M2 L9–12

Scale, Proportion, and Quantity	Aligned *PhD Science* Lessons
Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.	Level 3 M2 L1–2, 27–28 Level 3 M3 L1–3
Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	Level 3 M1 L4–10 Level 3 M3 L1–3, 14–15

Systems and System Models	Aligned *PhD Science* Lessons
A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.	Level 4 M1 L21–24 Level 4 M2 L15–23 Level 4 M4 L14–17, 26–27 Level 5 M2 L14, 18–19, 24–26 Level 5 M3 L6–8
A system can be described in terms of its components and their interactions.†	Level 3 M1 L1–3, 16–20 Level 3 M2 L6–15, 20–28 Level 3 M3 L9–11 Level 3 M4 L1–30

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Energy and Matter	Aligned *PhD Science* Lessons
Matter is made of particles.	Level 5 M1 L5–8, 23–26 Level 5 M2 L6–9, 14, 25–26 Level 5 M4 L3–4
Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.	Level 5 M2 L10–11, 25–26
Energy can be transferred in various ways and between objects.	Level 4 M2 L1–3, 8–26 Level 4 M3 L10–19, 30–31 Level 5 M1 L13–14 Level 5 M2 L15–19, 24–26 Level 5 M3 L10–11

Structure and Function	Aligned *PhD Science* Lessons
Different materials have different substructures, which can sometimes be observed.	Level 3 M2 L1–3
Substructures have shapes and parts that serve functions.	Level 3 M2 L9–12 Level 3 M3 L4–6, 21–28

Stability and Change	Aligned *PhD Science* Lessons
Change is measured in terms of differences over time and may occur at different rates.	Level 3 M1 L4–15, 27–29 Level 3 M2 L16–19 Level 3 M3 L7–8, 12–13, 19–20, 26–28
Some systems appear stable, but over long periods of time will eventually change.	Level 3 M1 L8–10

PhD Science® 3–5 Curriculum Correlation to *Kentucky Academic Standards for Science*: Level 4

The *PhD Science* Level 4 curriculum fully aligns with the Fourth Grade *Kentucky Academic Standards for Science*. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Fourth Grade

Performance Expectations: Physical Science		**Aligned *PhD Science* Lessons**
4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.	Level 4 M2 L6–7, 24–26
4-PS3-2	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.	Level 4 M2 L1–5, 10–11, 24–26
4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide.	Level 4 M2 L8–9, 24–26
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	Level 4 M2 L12–26
4-PS4-1	Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	Level 4 M3 L7–14, 29–31
4-PS4-2	Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.	Level 4 M4 L1–17, 25–27
4-PS4-3	Generate and compare multiple solutions that use patterns to transfer information.	Level 4 M4 L18–27

Performance Expectations: Life Science		Aligned *PhD Science* Lessons
4-LS1-1	Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	Level 4 M3 L1–6, 20, 26–31
4-LS1-2	Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.	Level 4 M3 L1–6, 15–25, 29–31
4-LS4-1	Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.	Level 3 M2 L1–8, 26–28

Performance Expectations: Earth and Space Science		Aligned *PhD Science* Lessons
4-ESS1-1	Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.	Level 4 M1 L1–5, 19–20, 25–27
4-ESS2-1	Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.	Level 4 M1 L6–11, 25–27
4-ESS2-2	Analyze and interpret data from maps to describe patterns of Earth's features.	Level 4 M1 L18–20, 25–27
4-ESS3-1	Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.	Level 4 M1 L21–27
4-ESS3-2	Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.	Level 4 M1 L12–17, 25–27

3–5 Engineering Design

Performance Expectations: Engineering, Technology, and Applications of Science		Aligned *PhD Science* Lessons
3–5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	Level 4 M2 L17–23
3–5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	Level 4 M1 L12–17 Level 4 M4 L14–17
3–5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	Level 4 M4 L14–17

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Ask questions about what would happen if a variable is changed.	Level 4 M3 L15–19
Identify scientific (testable) and nonscientific (non-testable) questions.	Level 3 M3 L12–13 Level 3 M4 L15–16, 19–21
Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause-and-effect relationships.†	Level 4 M1 L1–2, 23 Level 4 M2 L1–3, 8–9, 11, 25–26 Level 4 M3 L1–3, 6 Level 4 M4 L1–2
Use prior knowledge to describe problems that can be solved.	Level 3 M4 L22, 29–30 Level 5 M3 L19–23
Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.†	Level 4 M1 L12–17 Level 4 M2 L17–23 Level 4 M4 L14–17

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Developing and Using Models	Aligned *PhD Science* Lessons
Identify limitations of models.	Level 4 M4 L14–17, 26–27
Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.	Level 4 M2 L15–16 Level 4 M4 L3–8, 10–13
Develop a model using an analogy, example, or abstract representation to describe a scientific principle.†	Level 4 M1 L1–2, 26–27 Level 4 M2 L1–3, 8–11, 25–26 Level 4 M3 L1–3, 7–14, 30–31 Level 4 M4 L1–2
Develop a model to describe phenomena.†	Level 4 M1 L1–2, 26–27 Level 4 M2 L1–3, 8–9, 25–26 Level 4 M3 L1–3 Level 4 M4 L1–6
Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	Level 4 M4 L26–27
Use a model to test interactions concerning the functioning of a natural system.†	Level 4 M3 L7–11 Level 4 M4 L10–13, 18–24

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
Plan and conduct an investigation collaboratively in order to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.†	Level 4 M1 L8–11 Level 4 M2 L6–7 Level 4 M3 L15–19 Level 4 M4 L7–8, 18–21
Evaluate appropriate methods and/or tools for collecting data.	Level 4 M4 L7–8
Make observations and/or measurements in order to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.†	Level 4 M1 L6–11, 21–22 Level 4 M2 L10–14 Level 4 M3 L15–19 Level 4 M4 L9, 26–27
Make predictions about what would happen if a variable changes.	Level 3 M3 L12–13 Level 3 M4 L7–9, 15–16, 28–30 Level 5 M4 L5–6
Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	Level 4 M4 L14–17

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Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.	Level 3 M1 L4–12 Level 3 M3 L7–8, 27–28 Level 3 M4 L4–9 Level 5 M2 L3–5, 10–11 Level 5 M3 L4–5, 14–16 Level 5 M4 L14–15
Analyze and interpret data to make sense of phenomena, using logical reasoning.†	Level 4 M1 L12–20, 23–24, 26–27 Level 4 M2 L25–26 Level 4 M4 L10–13
Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.	Level 3 M3 L14–15, 19–20 Level 3 M4 L7–9 Level 5 M3 L14–16
Analyze data to refine a problem statement or the design of a proposed object, tool, or process.	Level 4 M4 L14–17
Use data to evaluate and refine design solutions.	Level 4 M4 L14–17

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.	Level 3 M4 L23–27 Level 5 M4 L5–6
Organize simple data sets to reveal patterns that suggest relationships.	Level 3 M1 L4–12 Level 3 M2 L3, 16–19 Level 3 M3 L7–8 Level 5 M4 L25–26
Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.	Level 4 M2 L8–9
Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.	Level 4 M4 L14–17

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Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard).	Level 4 M1 L6–7, 26–27 Level 4 M2 L25–26 Level 4 M3 L30–31 Level 4 M4 L18–21, 26–27
Use evidence (e.g., measurements, observations, patterns) to construct an explanation.†	Level 4 M1 L3–5, 25–27 Level 4 M2 L4–5, 15–16, 24–26 Level 4 M3 L4–5, 24–25, 29–31 Level 4 M4 L25–27
Identify the evidence that supports particular points in an explanation.†	Level 4 M1 L3–5, 10, 18, 21–22, 25–27
Apply scientific ideas to solve design problems.†	Level 4 M2 L17–23 Level 4 M4 L14–17, 26–27
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.†	Level 4 M1 L12–17 Level 4 M4 L14–17, 22–24

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Compare and refine arguments based on an evaluation of the evidence presented.	Level 4 M3 L21–23 Level 4 M4 L7–8
Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.	Level 5 M4 L5–6
Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.	Level 4 M3 L21–23
Construct an argument with evidence, data, and/or a model.†	Level 4 M3 L21–23, 26–28, 30–31
Use data to evaluate claims about cause and effect.	Level 3 M3 L19–20 Level 3 M4 L12–14 Level 5 M4 L24–26
Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	Level 3 M1 L21–26, 28–29 Level 3 M2 L20–21 Level 5 M3 L19–23

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Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.	Level 4 M1 L3–5 Level 4 M3 L30–31 Level 4 M4 L22–24
Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.	Level 3 M2 L13–15 Level 5 M2 L6–7, 20 Level 5 M3 L25–27
Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.	Level 5 M4 L18–19
Obtain and combine information from books and other reliable media to explain phenomena or solutions to a design problem.†	Level 4 M1 L3–5, 23–24 Level 4 M3 L4–6, 10–11, 20–23, 26–28
Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Level 4 M1 L23–24

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Disciplinary Core Ideas

Physical Science

PS3.A	**Definitions of Energy**	**Aligned *PhD Science* Lessons**
	The faster a given object is moving, the more energy it possesses.	Level 4 M2 L6–9, 12–16, 24–26
	Energy can be moved from place to place by moving objects or through sound, light, or electric currents.	Level 4 M2 L1–3, 10–11, 15–16, 24–26
PS3.B	**Conservation of Energy and Energy Transfer**	**Aligned *PhD Science* Lessons**
	Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.	Level 4 M2 L1–5, 8–9, 24–26
	Light also transfers energy from place to place.	Level 4 M2 L10–11, 24–26
	Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.	Level 4 M2 L1–3, 10–26
PS3.C	**Relationship Between Energy and Forces**	**Aligned *PhD Science* Lessons**
	When objects collide, the contact forces transfer energy so as to change the objects' motions.	Level 4 M2 L8–9, 24–26
PS3.D	**Energy in Chemical Processes and Everyday Life**	**Aligned *PhD Science* Lessons**
	The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.	Level 4 M2 L12–14, 24–26

PS4.A	Wave Properties	Aligned *PhD Science* Lessons
	Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach.	Level 4 M3 L7–14, 29–31
	Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	Level 4 M3 L7–14, 29–31
PS4.B	**Electromagnetic Radiation**	**Aligned *PhD Science* Lessons**
	An object can be seen when light reflected from its surface enters the eyes.	Level 4 M4 L1–17, 25–27
PS4.C	**Information Technologies and Instrumentation**	**Aligned *PhD Science* Lessons**
	Patterns can encode, send, receive, and decode information.	Level 4 M4 L18–27

Life Science

LS1.A	Structure and Function	Aligned *PhD Science* Lessons
	Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	Level 4 M3 L1–6, 20, 26–31
LS1.D	**Information Processing**	**Aligned *PhD Science* Lessons**
	Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.	Level 4 M3 L1–6, 15–25, 29–31
LS4.A	**Evidence of Common Ancestry and Diversity**	**Aligned *PhD Science* Lessons**
	Some kinds of plants and animals that once lived on Earth are no longer found anywhere. Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	Level 3 M2 L1–8, 26–28

Earth and Space Science

ESS1.C	**The History of Planet Earth**	**Aligned *PhD Science* Lessons**
	Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.	Level 4 M1 L1–5, 19–20, 25–27
ESS2.A	**Earth Materials and Systems**	**Aligned *PhD Science* Lessons**
	Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.	Level 4 M1 L6–11, 25–27
ESS2.B	**Plate Tectonics and Large-Scale System Interactions**	**Aligned *PhD Science* Lessons**
	The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth.	Level 4 M1 L18–20, 25–27
ESS2.E	**Biogeology**	**Aligned *PhD Science* Lessons**
	Living things affect the physical characteristics of their regions.	Level 4 M1 L6–11, 25–27
ESS3.A	**Natural Resources**	**Aligned *PhD Science* Lessons**
	Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.	Level 4 M1 L21–27
ESS3.B	**Natural Hazards**	**Aligned *PhD Science* Lessons**
	A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts.	Level 4 M1 L12–17, 25–27

Engineering, Technology, and Applications of Science

ETS1.A	Defining and Delimiting Engineering Problems	Aligned *PhD Science* Lessons
	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	Level 4 M2 L17–23
ETS1.B	**Developing Possible Solutions**	**Aligned *PhD Science* Lessons**
	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.	Level 4 M1 L12–17 Level 4 M4 L14–17
	At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	Level 4 M1 L12–17 Level 4 M4 L14–17
	Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	Level 4 M1 L12–17 Level 4 M4 L14–17
ETS1.C	**Optimizing the Design Solution**	**Aligned *PhD Science* Lessons**
	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	Level 4 M4 L14–17

Crosscutting Concepts

Patterns	**Aligned *PhD Science* Lessons**
Similarities and differences in patterns can be used to sort and classify natural phenomena and designed products.†	Level 4 M3 L7–9, 30–31 Level 4 M4 L22–27
Patterns of change can be used to make predictions.	Level 4 M4 L1–2
Patterns can be used as evidence to support an explanation.†	Level 4 M1 L1–5, 18–20, 26–27 Level 4 M2 L4–5, 8–11, 24–26 Level 4 M3 L1–3, 7–11, 20, 24–31 Level 4 M4 L3–4, 7–8, 14–17

Cause and Effect	**Aligned *PhD Science* Lessons**
Cause and effect relationships are routinely identified, tested, and used to explain change.†	Level 4 M1 L6–17, 21–27 Level 4 M2 L1–7, 10–14, 24–26 Level 4 M3 L6–23, 30–31 Level 4 M4 L3–13, 18–21, 25–27
Events that occur together with regularity might or might not be a cause and effect relationship.	Level 4 M1 L19–20, 25–27

Scale, Proportion, and Quantity	**Aligned *PhD Science* Lessons**
Observable phenomena exist from the very short to very long time periods.†	Level 4 M1 L3–5
Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	Level 3 M1 L4–10 Level 3 M3 L1–3, 14–15 Level 5 M1 L3–4, 13–17, 23–26 Level 5 M3 L1–3, 10–11, 25–27

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

Systems and System Models	Aligned *PhD Science* Lessons
A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.	Level 4 M1 L21–24 Level 4 M2 L15–23 Level 4 M4 L14–17, 26–27
A system can be described in terms of its components and their interactions.†	Level 4 M1 L1–2, 12–17 Level 4 M2 L1–11, 24–26 Level 4 M3 L7–9, 15–19, 21–23, 26–28, 30–31 Level 4 M4 L1–6, 10–13, 18–27

Energy and Matter	Aligned *PhD Science* Lessons
Matter is made of particles.	Level 5 M1 L5–8, 23–26 Level 5 M2 L6–9, 14, 25–26 Level 5 M4 L3–4
Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.	Level 5 M2 L10–11, 25–26
Energy can be transferred in various ways and between objects.†	Level 4 M2 L1–3, 8–26 Level 4 M3 L10–19, 30–31

Structure and Function	Aligned *PhD Science* Lessons
Different materials have different substructures, which can sometimes be observed.	Level 4 M3 L4–5, 20, 24–25 Level 4 M4 L7–9, 25–27
Substructures have shapes and parts that serve functions.	Level 4 M3 L4–6, 29–31

Stability and Change	Aligned *PhD Science* Lessons
Change is measured in terms of differences over time and may occur at different rates.	Level 4 M1 L3–11, 18–20, 25–27
Some systems appear stable, but over long periods of time will eventually change.	Level 3 M1 L8–10 Level 5 M2 L24–26 Level 5 M3 L14–16

†Element identified explicitly in the KY standards as the mechanism for how students demonstrate mastery at the end of instruction

PhD Science® 3–5 Curriculum Correlation to *Kentucky Academic Standards for Science*: Level 5

The *PhD Science* Level 5 curriculum fully aligns with the Fifth Grade *Kentucky Academic Standards for Science*. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Fifth Grade

Performance Expectations: Physical Science		**Aligned *PhD Science* Lessons**
5-PS1-1	Develop a model to describe that matter is made of particles too small to be seen.	Level 5 M1 L5–10, 23–26
5-PS1-2	Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.	Level 5 M1 L9–17, 23–26
5-PS1-3	Make observations and measurements to identify materials based on their properties.	Level 5 M1 L1–4, 11–17, 23–26
5-PS1-4	Conduct an investigation to determine whether the mixing of two or more substances results in new substances.	Level 5 M1 L1–2, 13–26
5-PS2-1	Support an argument that the gravitational force exerted by Earth on objects is directed down.	Level 5 M4 L3–4, 24–26
5-PS3-1	Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.	Level 5 M2 L15–19, 24–26

Performance Expectations: Life Science		**Aligned *PhD Science* Lessons**
5-LS1-1	Support an argument that plants get the materials they need for growth chiefly from air and water.	Level 5 M2 L3–5, 24–26
5-LS2-1	Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.	Level 5 M2 L1–2, 6–14, 20, 24–26

Performance Expectations: Earth and Space Science		Aligned *PhD Science* Lessons
5-ESS1-1	Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.	Level 5 M4 L18–19, 24–26
5-ESS1-2	Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.	Level 5 M4 L1–2, 5–17, 20–26
5-ESS2-1	Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.	Level 5 M3 L1–3, 6–13, 19–27
5-ESS2-2	Describe and graph the amounts and percentages of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.	Level 5 M3 L4–5, 19–27
5-ESS3-1	Obtain and combine information about solutions individual communities use to protect the Earth's resources and environment.	Level 5 M3 L14–18, 24–27

3–5 Engineering Design

Performance Expectations: Engineering, Technology, and Applications of Science		Aligned *PhD Science* Lessons
3–5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	Level 5 M2 L21–23
3–5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	Level 5 M3 L19–23
3–5-ETS1-3	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	Level 5 M1 L18–22

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Ask questions about what would happen if a variable is changed.	Level 4 M3 L15–19
Identify scientific (testable) and nonscientific (non-testable) questions.	Level 3 M3 L12–13 Level 3 M4 L15–16, 19–21
Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	Level 5 M1 L1–2 Level 5 M2 L1–2 Level 5 M3 L1–3 Level 5 M4 L1–2, 13
Use prior knowledge to describe problems that can be solved.	Level 5 M3 L19–23
Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.†	Level 5 M2 L21–23

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Developing and Using Models	Aligned *PhD Science* Lessons
Identify limitations of models.	Level 5 M1 L5–6 Level 5 M2 L14 Level 5 M3 L6–8, 25–27
Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.	Level 5 M1 L5–6 Level 5 M2 L1–2, 6–7 Level 5 M4 L1–2, 7–8, 14–17
Develop a model using an example to describe a scientific principle.†	Level 5 M1 L7–8 Level 5 M2 L20, 25–26 Level 5 M3 L6–8, 10–11, 24–27 Level 5 M4 L3–4, 24–26
Develop or use models to describe phenomena.†	Level 5 M1 L1–2, 9–10, 13–14, 23–26 Level 5 M2 L1–2, 6–7, 14 Level 5 M3 L1–3, 9, 12–16, 25–27 Level 5 M4 L13, 20–26
Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	Level 5 M3 L19–23
Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Level 5 M3 L12–13 Level 5 M4 L9–12

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Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
Plan and conduct an investigation collaboratively in order to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.†	Level 5 M1 L18–22 Level 5 M2 L3–5 Level 5 M4 L25–26
Evaluate appropriate methods and/or tools for collecting data.	Level 5 M2 L3–5
Make observations and measurements in order to produce data to serve as the basis for evidence for an explanation of a phenomenon.†	Level 5 M1 L13–14, 24–26 Level 5 M3 L10–11 Level 5 M4 L18–19
Make predictions about what would happen if a variable changes.	Level 5 M4 L5–6
Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	Level 4 M4 L14–17

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Represent data in graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.†	Level 5 M2 L3–5, 10–11 Level 5 M3 L4–5, 14–16 Level 5 M4 L14–15
Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.	Level 5 M1 L15–17, 24–26 Level 5 M2 L8–9, 12–13, 15–17, 25–26 Level 5 M3 L4–5, 25–27
Compare and contrast data collected by different groups in order to discuss similarities and differences in their findings.	Level 5 M3 L14–16
Analyze data to refine a problem statement or the design of a proposed object, tool, or process.	Level 4 M4 L14–17
Use data to evaluate and refine design solutions.	Level 4 M4 L14–17

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Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.	Level 5 M4 L5–6
Organize simple data sets to reveal patterns that suggest relationships.	Level 5 M4 L25–26
Describe or measure and graph quantities such as area, volume, and weight to address scientific and engineering questions and problems.†	Level 5 M1 L3–4, 15–17 Level 5 M3 L10–11, 24–27
Create and/or use graphs and/or charts generated from simple algorithms to compare alternative solutions to an engineering problem.	Level 4 M4 L14–17

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard).	Level 5 M2 L12–13, 25–26 Level 5 M4 L22–26
Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.	Level 5 M1 L5–6, 23–26 Level 5 M2 L15–17, 24–26 Level 5 M3 L17–18, 25–27 Level 5 M4 L24–26
Identify the evidence that supports particular points in an explanation.	Level 5 M1 L11–12, 23–26 Level 5 M2 L24–26 Level 5 M4 L20–21, 24–26
Apply scientific ideas to solve design problems.	Level 5 M4 L9–12
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.†	Level 5 M1 L18–22 Level 5 M2 L21–23 Level 5 M3 L19–23 Level 5 M4 L3–4

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Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Compare and refine arguments based on an evaluation of the evidence presented.	Level 3 M3 L16–18 Level 4 M3 L21–23 Level 4 M4 L7–8
Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.	Level 5 M4 L5–6
Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.	Level 5 M2 L3–5, 21–23, 25–26
Support an argument with evidence, data, or a model.†	Level 5 M1 L3–4, 24–26 Level 5 M2 L3–5, 8–11, 25–26 Level 5 M3 L25–27 Level 5 M4 L13–17, 20–21, 24–26
Use data to evaluate claims about cause and effect.	Level 5 M4 L24–26
Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	Level 5 M3 L19–23

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence.	Level 5 M2 L10–11, 18–19, 25–26
Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.	Level 5 M2 L6–7, 20 Level 5 M3 L25–27
Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.	Level 5 M4 L18–19
Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.†	Level 5 M3 L9, 14–16, 19–27
Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Level 3 M2 L20–21 Level 4 M1 L23–24

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Disciplinary Core Ideas

Physical Science

PS1.A	**Structure and Properties of Matter**	**Aligned *PhD Science* Lessons**
	Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	Level 5 M1 L5–10, 23–26
	The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.	Level 5 M1 L9–17, 23–26
	Measurements of a variety of properties can be used to identify materials.	Level 5 M1 L1–4, 11–17, 23–26
PS1.B	**Chemical Reactions**	**Aligned *PhD Science* Lessons**
	When two or more different substances are mixed, a new substance with different properties may be formed.	Level 5 M1 L1–2, 15–26
	No matter what reaction or change in properties occurs, the total weight of the substances does not change.	Level 5 M1 L9–17, 23–26
PS2.B	**Types of Interactions**	**Aligned *PhD Science* Lessons**
	The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	Level 5 M4 L3–4, 24–26
PS3.D	**Energy in Chemical Processes and Everyday Life**	**Aligned *PhD Science* Lessons**
	The energy released from food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).	Level 5 M2 L6–7, 15–19, 24–26

Life Science

LS1.C	Organization for Matter and Energy Flow in Organisms	Aligned *PhD Science* Lessons
	Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.	Level 5 M2 L8–9, 15–19, 24–26
	Plants acquire their material for growth chiefly from air and water.	Level 5 M2 L3–5, 24–26
LS2.A	**Interdependent Relationships in Ecosystems**	**Aligned *PhD Science* Lessons**
	The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plant parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem.	Level 5 M2 L1–2, 8–14, 20, 24–26
LS2.B	**Cycles of Matter and Energy Transfer in Ecosystems**	**Aligned *PhD Science* Lessons**
	Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases and water from the environment, and then release waste matter (gas, liquid, or solid) back into the environment.	Level 5 M2 L6–7, 10–14, 24–26

Earth and Space Science

ESS1.A	**The Universe and Its Stars**	**Aligned *PhD Science* Lessons**
	The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth.	Level 5 M4 L18–19, 24–26
ESS1.B	**Earth and the Solar System**	**Aligned *PhD Science* Lessons**
	The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its north and south poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.	Level 5 M4 L1–2, 5–17, 20–26
ESS2.A	**Earth Materials and Systems**	**Aligned *PhD Science* Lessons**
	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.	Level 5 M3 L1–13, 24–27
ESS2.C	**The Roles of Water in Earth's Surface Processes**	**Aligned *PhD Science* Lessons**
	Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.	Level 5 M3 L4–5, 24–27
ESS3.C	**Human Impacts on Earth Systems**	**Aligned *PhD Science* Lessons**
	Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, oceans, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.	Level 5 M3 L14–27

Engineering, Technology, and Applications of Science

ETS1.A	**Defining and Delimiting Engineering Problems**	**Aligned *PhD Science* Lessons**
	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	Level 5 M2 L21–23
ETS1.B	**Developing Possible Solutions**	**Aligned *PhD Science* Lessons**
	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.	Level 5 M3 L19–23
	At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	Level 5 M2 L21–23 Level 5 M3 L19–23
	Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	Level 5 M1 L18–22
ETS1.C	**Optimizing the Design Solution**	**Aligned *PhD Science* Lessons**
	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	Level 5 M1 L18–22

Crosscutting Concepts

Patterns	**Aligned *PhD Science* Lessons**
Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena.†	Level 5 M4 L5–6, 13–17, 22–23
Patterns of change can be used to make predictions.	Level 5 M4 L9–12, 20–21, 24–26
Patterns can be used as evidence to support an explanation.	Level 5 M1 L7–8 Level 5 M2 L1–5, 8–9, 15–17, 25–26 Level 5 M3 L6–9 Level 5 M4 L1–4, 7–8, 24–26

Cause and Effect	**Aligned *PhD Science* Lessons**
Cause and effect relationships are routinely identified, tested, and used to explain change.†	Level 5 M1 L1–2, 5–6, 9–10, 18–22, 24–26 Level 5 M2 L3–7, 12–13, 18–19, 21–23, 25–26 Level 5 M3 L6–8, 12–13, 17–18, 25–27 Level 5 M4 L5–6, 24–26
Events that occur together with regularity might or might not be a cause and effect relationship.	Level 5 M2 L20 Level 5 M3 L14–16

Scale, Proportion, and Quantity	**Aligned *PhD Science* Lessons**
Natural objects exist from the very small to the immensely large.†	Level 5 M1 L23–26 Level 5 M2 L10–11 Level 5 M3 L4–5, 24–27 Level 5 M4 L18–19, 24–26
Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.†	Level 5 M1 L3–4, 13–17, 23–26 Level 5 M3 L1–3, 10–11, 25–27

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Systems and System Models	Aligned *PhD Science* Lessons
A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.	Level 5 M2 L14, 18–19, 24–26 Level 5 M3 L6–8
A system can be described in terms of its components and their interactions.†	Level 5 M1 L3–4, 15–17 Level 5 M2 L1–2, 6–11, 24–26 Level 5 M3 L1–9, 12–13, 19–27 Level 5 M4 L1–2, 7–26

Energy and Matter	Aligned *PhD Science* Lessons
Matter is made of particles.	Level 5 M1 L5–8, 23–26 Level 5 M2 L6–9, 14, 25–26 Level 5 M4 L3–4
Matter is transported into, out of, and within systems.	Level 5 M2 L10–11, 25–26
Energy can be transferred in various ways and between objects.†	Level 5 M1 L13–14 Level 5 M2 L15–19, 24–26 Level 5 M3 L10–11

Structure and Function	Aligned *PhD Science* Lessons
Different materials have different substructures, which can sometimes be observed.	Level 3 M2 L1–3 Level 4 M3 L4–5, 20, 24–25 Level 4 M4 L7–9, 25–27
Substructures have shapes and parts that serve functions.	Level 3 M2 L9–12 Level 3 M3 L4–6, 21–28 Level 4 M3 L4–6, 29–31

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Stability and Change	Aligned *PhD Science* Lessons
Change is measured in terms of differences over time and may occur at different rates.	Level 5 M1 L1–2, 9–12, 18–26 Level 5 M2 L12–13, 20, 25–26 Level 5 M3 L17–18 Level 5 M4 L5–6, 9–12, 24–26
Some systems appear stable, but over long periods of time will eventually change.	Level 5 M2 L24–26 Level 5 M3 L14–16