3rd Grade – Thematic Model – Bundle 1
Movement and Interaction of Objects

This is the first bundle of the 3rd Grade Thematic Model. Each bundle has connections to the other bundles in the course, as shown in the Course Flowchart.

Bundle 1 Question: This bundle is assembled to address the question "how do objects affect the motion of other objects?"

Summary

The bundle organizes performance expectations with a focus on helping students understand the cause and affect relationships between objects when they interact and move. Instruction developed from this bundle should always maintain the three-dimensional nature of the standards, and recognize that instruction is not limited to the practices and concepts directly linked with any of the bundle performance expectations.

Connections between bundle DCIs

Although objects in contact exert forces on each other (PS2.B as in 3-PS2-1), electric and magnetic forces between a pair of objects do not require that the objects be in contact (PS2.B as in 3-PS2-3 and 3-PS2-4). 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 (PS2.A as in 3-PS2-1). 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 (PS2.A as in 3-PS2-2).

The idea of determining patterns and using them to make predictions connects to the idea that 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 (ESS2.D as in 3-ESS2-1).

The engineering design idea that different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints (ETS1.C as in 3-5-ETS1-3) could connect to multiple science concepts such as that forces that do not sum to zero can cause changes in the object's speed or direction of motion (PS2.A as in 3-PS2-1) and that the size of the forces between two magnets depends on the properties of the magnets, their distance apart, and on their orientation relative to each other (PS2.B as in 3-PS2-3). The first connection could be made by challenging students to determine whether balanced or unbalanced forces will best solve the problem of changing the speed or direction of motion. The second connection could be made by supporting students to design a way to move something using magnets. In either case, criteria and constraints should be determined by the class before beginning to design a solution and students' solutions can be tested to determine which best solves the problem, given the criteria and constraints.

Bundle Science and Engineering Practices

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the practices of asking questions and defining problems (3-PS2-3 and 3-PS2-4), planning and carrying out investigations (3-PS2-1, 3-PS2-2, and 3-5-ETS1-3), and analyzing and interpreting data (3-ESS2-1). Many other practice elements can be used in instruction.

Bundle Crosscutting Concepts

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the crosscutting concepts of Patterns (3-PS2-2 and 3-ESS2-1) and Cause and Effect (3-PS2-1 and 3-PS2-3). Many other crosscutting concepts elements can be used in instruction.

All instruction should be three-dimensional.

Performance Expectations 3-ESS2-1 and 3-5-ETS1-3 are partially assessable.	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.** [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [*Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*] 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.** [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [*Assessment Boundary: Assessment does not include technical terms such as period and frequency.*] 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.** [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] *[Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.]* 3-PS2-4. **Define a simple design problem that can be solved by applying scientific ideas about magnets.*** [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.] 3-ESS2-1. **Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.** [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [*Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.*] 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.**
Example Phenomena	If two students push on opposite sides of a chair, the chair doesn't move. Larger magnets can pick up larger objects than can small magnets.
Additional Practices Building to the PEs	**Asking Questions and Defining Problems** ● Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Students could *ask questions* [about] ***the patterns of an object's motion*** *that can be investigated, and predict reasonable outcomes*. 3-PS2-2 **Developing and Using Models** ● Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Students could *collaboratively develop a model* [of] ***forces causing changes in an object's speed or direction of motion*** *based on evidence that shows the relationships among variables for frequent and regular occurring events*. 3-PS2-1

Additional Practices Building to the PEs (Continued)	**Planning and Carrying Out Investigations** ● Make predictions about what would happen if a variable changes. Students could make predictions about what would happen [to] ***the sizes of the forces between two magnets*** *if* ***their orientation relative to each other*** *changes*. 3-PS2-3 and 3-PS2-4 **Analyzing and Interpreting Data** ● Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. Students could ***observe and measure an object's motion in various situations***, *represent* [the] *data in tables and/or various graphical displays to reveal patterns*, [and use any] ***regular patterns*** [to] ***predict future motion***. 3-PS2-2 **Using Mathematical and Computational Thinking** ● Organize simple data sets that suggest relationships. Students can *organize simple data sets* [to reveal] ***patterns of the weather across different times and areas***. 3-ESS2-1 **Constructing Explanations and Designing Solutions** ● Construct an explanation of observed relationships (e.g., the distribution of plants in the back yard). Students could *construct an explanation of observed relationships* [between] ***the sizes of the forces*** [between two objects and] ***their distances apart***. 3-PS2-3 and 3-PS2-4 **Engaging in Argument from Evidence** ● 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. Students could *make a claim about the merit of a solution* [that uses the idea that] ***objects in contact exert forces on each other***. 3-PS2-1 **Obtaining, Evaluating, and Communicating Information** ● Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts. Students could *communicate technical information* [about how] ***scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next***. 3-ESS2-1
Additional Crosscutting Concepts Building to the PEs	**Systems and System Models** ● A system can be described in terms of its components and their interactions. Students could describe how ***objects in contact exerting forces on each other*** [are] *components* [of] *a system.* 3-PS2-1

Additional Crosscutting Concepts Building to the PEs (Continued)	**Scale, Proportion, and Quantity** ● Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. Students could ***measure the patterns of an object's motion in various situations***, [and describe how] *using standard units* [helps with communication of the patterns]. 3-PS2-2 **Stability and Change** ● Change is measured in terms of differences over time and may occur at different rates. Students can use ***patterns of the weather across different times and areas*** [to describe] *that change is measured in terms of differences over time and may occur at different rates*. 3-ESS2-1
Additional Connections to Nature of Science	**Scientific Knowledge is Based on Empirical Evidence** ● Scientists use tools and technologies to make accurate measurements and observations. Students could describe how *scientists use tools and technologies to make accurate measurements and observations*, [including of] ***patterns of the weather across different times and areas***. 3-ESS2-1 **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Science assumes consistent patterns in natural systems. Students could describe that we can ***predict future motion from past motion when that past motion exhibits a regular pattern*** *because science assumes consistent patterns in natural systems*. 3-PS2-2

3-PS2-1 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

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.** [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [*Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

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Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Science investigations use a variety of methods, tools, and techniques.

Disciplinary Core Ideas

PS2.A: Forces and Motion

- 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. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)

PS2.B: Types of Interactions

- Objects in contact exert forces on each other.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified.

Observable features of the student performance by the end of the grade:

1	Identifying the phenomenon under investigation	
	a	Students identify and describe* the phenomenon under investigation, which includes the effects of different forces on an object's motion (e.g., starting, stopping, or changing direction).
	b	Students describe* the purpose of the investigation, which includes producing data to serve as the basis for evidence for how balanced and unbalanced forces determine an object's motion.
2	Identifying the evidence to address the purpose of the investigation	
	a	Students collaboratively develop an investigation plan. In the investigation plan, students describe* the data to be collected, including:
		i. The change in motion of an object at rest after:
		1. Different strengths and directions of balanced forces (forces that sum to zero) are applied to the object.
		2. Different strengths and directions of unbalanced forces (forces that do not sum to zero) are applied to the object (e.g., strong force on the right, weak force or the left).
		ii. What causes the forces on the object.
	b	Students individually describe* how the evidence to be collected will be relevant to determining the effects of balanced and unbalanced forces on an object's motion.
3	Planning the investigation	
	a	In the collaboratively developed investigation plan, students describe* how the motion of the object will be observed and recorded, including defining the following features:
		i. The object whose motion will be investigated.

		ii.	The objects in contact that exert forces on each other.
		iii.	Changing one variable at a time (e.g., control strength and vary the direction, or control direction and vary the strength).
		iv.	The number of trials that will be conducted in the investigation to produce sufficient data.
	b	Students individually describe* how their investigation plan will allow them to address the purpose of the investigation.	
4	Collecting the data		
	a	Students collaboratively collect and record data according to the investigation plan they developed, including data from observations and/or measurements of:	
		i.	An object at rest and the identification of the forces acting on the object.
		ii.	An object in motion and the identification of the forces acting on the object.

3-PS2-2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

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.** [Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.] [*Assessment Boundary: Assessment does not include technical terms such as period and frequency.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- 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.

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Connections to Nature of Science

Science Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns.

Disciplinary Core Ideas

PS2.A: Forces and Motion

- 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. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)

Crosscutting Concepts

Patterns

- Patterns of change can be used to make predictions.

Observable features of the student performance by the end of the grade:			
1	Identifying the phenomenon under investigation		
	a	From the given investigation plan, students identify and describe* the phenomenon under investigation, which includes observable patterns in the motion of an object.	
	b	Students identify and describe* the purpose of the investigation, which includes providing evidence for an explanation of the phenomenon that includes the idea that patterns of motion can be used to predict future motion of an object.	
2	Identifying the evidence to address the purpose of the investigation		
	a	Based on a given investigation plan, students identify and describe* the data to be collected through observations and/or measurements, including data on the motion of the object as it repeats a pattern over time (e.g., a pendulum swinging, a ball moving on a curved track, a magnet repelling another magnet).	
	b	Students describe* how the data will serve as evidence of a pattern in the motion of an object and how that pattern can be used to predict future motion.	
3	Planning the investigation		
	a	From the given investigation plan, students identify and describe* how the data will be collected, including how:	
		i.	The motion of the object will be observed and measured.
		ii.	Evidence of a pattern in the motion of the object will be identified from the data on the motion of the object.
		iii.	The pattern in the motion of the object can be used to predict future motion.
4	Collecting the data		
	a	Students make observations and/or measurements of the motion of the object, according to the given investigation plan, to identify a pattern that can be used to predict future motion.	

3-PS2-3 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

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.** [Clarification Statement: Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.] [*Assessment Boundary: Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Ask questions that can be investigated based on patterns such as cause and effect relationships.

Disciplinary Core Ideas

PS2.B: Types of Interactions

- 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.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change.

Observable features of the student performance by the end of the grade:			
1	Addressing phenomena of the natural world		
	a	Students ask questions that arise from observations of two objects not in contact with each other interacting through electric or magnetic forces, the answers to which would clarify the cause-and-effect relationships between:	
		i.	The sizes of the forces on the two interacting objects due to the distance between the two objects.
		ii.	The relative orientation of two magnets and whether the force between the magnets is attractive or repulsive.
		iii.	The presence of a magnet and the force the magnet exerts on other objects.
		iv.	Electrically charged objects and an electric force.
2	Identifying the scientific nature of the question		
	a	Students' questions can be investigated within the scope of the classroom.	

3-PS2-4 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

3-PS2-4. **Define a simple design problem that can be solved by applying scientific ideas about magnets.*** [Clarification Statement: Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems
Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple problem that can be solved through the development of a new or improved object or tool.

Disciplinary Core Ideas

PS2.B: Types of Interactions

- 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.

Crosscutting Concepts

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Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.

Observable features of the student performance by the end of the grade:			
1	Identifying the problem to be solved		
	a	Students identify and describe* a simple design problem that can be solved by applying a scientific understanding of the forces between interacting magnets.	
	b	Students identify and describe* the scientific ideas necessary for solving the problem, including:	
		i.	Force between objects do not require that those objects be in contact with each other
		ii.	The size of the force depends on the properties of objects, distance between the objects, and orientation of magnetic objects relative to one another.
2	Defining the criteria and constraints		
	a	Students identify and describe* the criteria (desirable features) for a successful solution to the problem.	
	b	Students identify and describe* the constraints (limits) such as:	
		i.	Time.
		ii.	Cost.
		iii.	Materials.

3-ESS2-1 Earth's Systems

Students who demonstrate understanding can:

3-ESS2-1. **Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.** [Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [*Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data
Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.

- Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.

Disciplinary Core Ideas

ESS2.D: Weather and Climate

- 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.

Crosscutting Concepts

Patterns

- Patterns of change can be used to make predictions.

Observable features of the student performance by the end of the grade:			
1	Organizing data		
	a	Students use graphical displays (e.g., table, chart, graph) to organize the given data by season using tables, pictographs, and/or bar charts, including:	
		i.	Weather condition data from the same area across multiple seasons (e.g., average temperature, precipitation, wind direction).
		ii.	Weather condition data from different areas (e.g., hometown and nonlocal areas, such as a town in another state).
2	Identifying relationships		
	a	Students identify and describe* patterns of weather conditions across:	
		i.	Different seasons (e.g., cold and dry in the winter, hot and wet in the summer; more or less wind in a particular season).
		ii.	Different areas (e.g., certain areas (defined by location, such as a town in the Pacific Northwest), have high precipitation, while a different area (based on location or type, such as a town in the Southwest) have very little precipitation).
3	Interpreting data		
	a	Students use patterns of weather conditions in different seasons and different areas to predict:	
		i.	The typical weather conditions expected during a particular season (e.g., "In our town in the summer it is typically hot, as indicated on a bar graph over time, while in the winter it is typically cold; therefore, the prediction is that next summer it will be hot and next winter it will be cold.").
		ii.	The typical weather conditions expected during a particular season in different areas.

3-5-ETS1-3 Engineering Design

Students who demonstrate understanding can:

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.

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**ETS1.B: Developing Possible Solutions** • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. **ETS1.C: Optimizing the Design Solution** • Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.	

Observable features of the student performance by the end of the grade:			
1	Identifying the purpose of the investigation		
	a	Students describe* the purpose of the investigation, which includes finding possible failure points or difficulties to identify aspects of a model or prototype that can be improved.	
2	Identifying the evidence to be address the purpose of the investigation		
	a	Students describe* the evidence to be collected, including:	
		i.	How well the model/prototype performs against the given criteria and constraints.
		ii.	Specific aspects of the prototype or model that do not meet one or more of the criteria or constraints (i.e., failure points or difficulties).
		iii.	Aspects of the model/prototype that can be improved to better meet the criteria and constraints.
	b	Students describe* how the evidence is relevant to the purpose of the investigation.	
3	Planning the investigation		
	a	Students create a plan for the investigation that describes* different tests for each aspect of the criteria and constraints. For each aspect, students describe*:	
		i.	The specific criterion or constraint to be used.
		ii.	What is to be changed in each trial (the independent variable).
		iii.	The outcome (dependent variable) that will be measured to determine success.
		iv.	What tools and methods are to be used for collecting data.
		v.	What is to be kept the same from trial to trial to ensure a fair test.
4	Collecting the data		
	a	Students carry out the investigation, collecting and recording data according to the developed plan.	