Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.1 Identify questions suitable for generating a hypothesis.
Taxonomy Level: 1.1-C Remember Procedural Knowledge

Previous/Future knowledge: In 3rd grade (3-1.3), students generated questions such as "what if?" or "how?" about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation. In 4th grade (4-1.3), students summarized the characteristics of a simple scientific investigation that represent a fair test (including asking a question that identifies a problem). Students have not been introduced to the concept of hypothesis prior to this grade. In 7th grade (7-1.2), students will generate questions that can be answered through scientific investigation. In 8th grade (8-1.4), students will generate questions for further study on the basis of prior investigations.

It is essential for students to know that only *testable questions*, which are used to test one variable, are suitable for scientific investigations. The question should include the relationship between the *independent* (manipulated) variable and *dependent* (responding) variable. For example, the following are testable questions:

- How does the amount of space affect the population of fish in a pond?
  - The independent (manipulated) variable is size of the pond.
  - The dependent (responding) variable is the population of fish in the pond.
- What is the effect of slope of the land on the amount of soil erosion?
  - The independent (manipulated) variable is the slope of the land.
  - The dependent (responding) variable is the amount of soil erosion.
- How does stirring affect the rate that salt dissolves in water?
  - The independent (manipulated) variable is the stirring.
  - The dependent (responding) variable is the time to dissolve.

It is also essential for students to know that a prediction about the relationship between variables is formed from the testable question. This prediction is called a *hypothesis*.

- All controlled investigations should have a hypothesis.
- A hypothesis can be stated positively or negatively. For example,
  - The smaller the pond, the smaller the population of fish. (negative statement)
  - The greater the slope of the land, the more soil erosion will be observed. (positive statement)
  - The faster the stirring, the shorter amount of time it will take to dissolve the salt. (positive statement)
- A hypothesis can also be stated as a cause-and-effect ("If…then,…") statement. For example, "If there is more food available, then the population of fish will increase."
- The experiment is conducted to support or not support a hypothesis. If the hypothesis is not supported by the experiment, it can still be used to help rule out some other ideas.

NOTE TO TEACHER: In 4th grade (4-1.3), students generated predictions to the testable questions. In 5th grade, students will continue to generating these predictions, but use the term hypothesis.

It is not essential for students to conduct an investigation for every question they generate or generate questions based on prior investigations.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Assessment Guidelines:

The objective of this indicator is to *identify* questions suitable for generating a hypothesis; therefore, the primary focus of assessment should be to recognize a question that leads to a hypothesis. However, appropriate assessments should also require students to *recognize* an appropriate hypothesis from a testable question or investigation; *recognize* that a testable question should have a manipulated and responding variable; or *identify* the manipulated and responding variables in a question.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.2 Identify independent (manipulated), dependent (responding), and controlled variables in an experiment.
Taxonomy Level: 1.1-B Remember Conceptual Knowledge

Previous/Future knowledge: In 4th grade (4-1.5), students recognized the correct placement of variables on a line graph. In 7th grade (7-1.5), students will explain the relationship between independent and dependent variables in controlled a scientific investigation through the use of appropriate graphs, tables, and charts.

It is essential for students to know that in an experiment there are three types of variables.

- The manipulated variable (changed or tested in the experiment) is also called the *independent variable*.
- The variables that are kept the same, or unchanged, in the experiment are called the *controlled variables*.
- The responding variable (the result of, or response to, the manipulated variable) is also called the *dependent variable*.

For example, a student conducts an experiment to test whether changing the surface of the floor will increase the distance a toy car will roll. The student uses carpet, rubber mat, and the floor. When the car is pushed with the same amount of force on each surface, the student finds that it rolls farther on the floor than the carpet or rubber mat. The independent (manipulated) variable is the surface of the floor. The controlled variables are the size of the carpet and rubber mat, the same toy car, and the force with which the car is pushed. The dependent (responding) variable is the distance the car rolled.

NOTE TO TEACHER: Students should be using both terms independent (manipulated) and dependent (responding) when describing variables.

Assessment Guidelines:
The objective of this indicator is to *identify* variables in an experiment; therefore, the primary focus of assessment should be to recognize a variable as independent (manipulated), dependent (responding), and controlled in an experiment.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.
Taxonomy Level: 6.2 and 3.1 Create and Apply Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-1.3), students carried out simple scientific investigations when given clear directions. In 2nd grade (2-1.1), students carried out simple scientific investigations to answer questions about familiar objects and events. In 4th grade, students summarized the characteristics of a simple scientific investigation that represent a fair test (including a question that identifies the problem, a prediction that indicates a possible outcome, a process that tests one manipulated variable at a time, and results that are communicated and explained) (4-1.3) and constructed and interpreted diagrams, tables, and graphs made from recorded measurements and observations (4-1.6). In 7th grade, students will explain the reasons for testing one independent variable at a time in a controlled scientific investigation (7-1.3) and will explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation (7-1.4). In 8th grade, students will design a controlled scientific investigation (8-1.1) and will explain the importance of and requirements for replication of scientific investigations (8-1.5).

It is essential for students to know that a *controlled scientific investigation* determines the effect of an independent variable in an experiment, when all other variables are controlled. Every controlled scientific investigation provides information. This information is called *data*. Data includes both scientific observations and inferences.

- A *scientific observation* is gained by carefully identifying and describing properties using the five senses or scientific tools and can be classified as *quantitative* or *qualitative*.
  - Quantitative observations are observations that use numbers (amounts) or measurements (including the unit label) or observations that make relative comparisons, such as more than, all, less than, few, or none.
  - Qualitative observations are observations that are made using only the senses and refer to specific properties.
- An *inference* is an explanation or interpretation of an observation based on prior experiences or supported by observations made in the investigation. They are not final explanations of the observation. There may be several logical inferences for a given observation. There is no way to be sure which inference best explains the observation without further investigation.

In order to design a *controlled scientific investigation* some or all of the following steps should be included:

- Identify a testable question (tests one variable) that can be investigated
- Research information about the topic
- State the hypothesis as a predicted answer to the question, what may be the possible outcome of the investigation
- Design an experiment to test the hypothesis, controlling all variables except the independent (manipulated) variable
  - Plan for independent (manipulated) and dependent (responding) variables
  - Plan for factors that should be held constant (controlled variables)
  - List the materials needed to conduct the experiment
  - List the procedures to be followed
  - Plan for recording, organizing and analyzing data
- Conduct the experiment and record data (observations) in tables, graphs, or charts

- Analyze the data in the tables, graphs, or charts to figure out what the data means (describe the relationship between the variables)
- Compare the results to the hypothesis and write a conclusion that will support or not support the hypothesis based on the recorded data
- Communicate the results to others

It is essential for students to conduct a controlled scientific investigation after planning the experimental design.

- Appropriate tools should be selected and used.
- Appropriate safety precautions should be taken when conducting the investigation.
- Measurements and observations should be recorded accurately in the appropriate table, chart, or graph.

It is not essential for students to design or conduct an experiment that includes a controlled set-up (7-1.3).

Assessment Guidelines:

One objective of this indicator is to *plan* controlled scientific investigations, manipulating one variable at a time; therefore, the primary focus of assessment should be to design the procedures for completing a scientific investigation where one variable is manipulated. However, appropriate assessments should also require students to *recognize* steps appropriate for conducting a controlled investigation; *detect* inappropriate steps in a given investigation; or *organize* the results of the investigation in tables or charts.

Another objective of this indicator is to *conduct* controlled scientific investigations, manipulating one variable at a time; therefore, the primary focus of assessment should be to carry out the procedures for completing a scientific investigation where one variable is manipulated. However, appropriate assessments should also require students to *summarize* the steps of a controlled investigation; *use* appropriate tools and safety precautions when conducting the investigation; *identify* appropriate tools for an investigation; *recognize* measurements and observations that are accurate and inaccurate in an investigation.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.4 Use appropriate tools and instruments (including a timing device and a 10x magnifier) safely and accurately when conducting a controlled scientific investigation.
Taxonomy Level: 3.2-C Apply Procedural Knowledge

Previous/future knowledge: In previous grades, students used magnifiers and eyedroppers (K-1.2), rulers (1-1.2), thermometers, rain gauges, balances, and measuring cups (2-1.2), beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes (3-1.5), and a compass, an anemometer, mirrors, and a prism (4-1.2) safely, accurately, and appropriately. In future grades, students will continue to use these tools, when appropriate, as well as use new tools when collecting scientific data. A complete list of tools can be found in Appendix A of the Academic Standards.

It is essential for students to know that different instruments or tools are needed to collect different kinds of data.

- A *timing device* is an instrument used to measure time.
  - An example of a timing device is a stop watch or clock with a second hand.
  - Time is measured in seconds (s), minutes (min), hours (hr), and days.
- A *10x magnifier* is a tool that is used to enlarge objects or see details.
  - Objects seen through a 10x magnifier look ten times larger than they do with the unaided eye.

It is essential for students to use care when handling these tools when gathering data.

- Care should be taken not to break or drop the timing device or magnifier.

It is also essential for students to use tools from previous grade levels that are appropriate to the content of this grade level such as eyedroppers, magnifiers, rulers (measuring to centimeters or millimeters), pan balances (measuring in grams), thermometers (measuring in ^{o}F and ^{o}C), beakers (measuring liters or milliliters), forceps/tweezers, graduated cylinders (measuring in milliliters), graduated syringes (measuring in milliliters), meter sticks and meter tapes (measuring in meters, centimeters, or millimeters), or compasses to gather data. Other units of measurement that students should be familiar with are kilograms (mass) or kilometers (distance).

NOTE TO TEACHER: See information in previous grades regarding how to use each tool.
All temperature readings during investigations will be taken using the Celsius scale unless the data refers to weather when the Fahrenheit scale is used.

It is not essential for students to know how to use spring scales or a more complex magnifier such as a microscope. Tools from previous grades that are not appropriate to the content of this grade level are not essential; however, these terms may be used as distracters (incorrect answer options) for assessment, for example measuring cups, rain gauges, tuning forks, anemometers, mirrors (plane/flat), or prisms. Students do not need to convert measurements from English to metric or metric to English.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Assessment Guidelines:

The objective of this indicator is to *use* tools safely, accurately, and appropriately when gathering data; therefore, the primary focus of assessment should be to apply correct procedures to the use of a timing device, a 10x magnifier, and other tools essential to the grade level that would be needed to conduct a science investigation. However, appropriate assessments should also require students to *identify* appropriate uses for a timing device, or a 10x magnifier; *illustrate* the appropriate tool for an investigation using pictures, diagrams, or words; *recall* how to accurately determine the measurement from the tool; or *recognize* ways to use science tools safely, accurately, and appropriately.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.5 Construct a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables.
Taxonomy Level: 6.3-C Create Procedural Knowledge

Previous/Future knowledge: In 4th grade, students recognized the correct placement of variables on a line graph (4-1.5) and constructed and interpreted diagrams, tables, and graphs made from recorded measurements and observations (4-1.6). In 7th grade (7-1.5), students will explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.

It is essential for students to know that line graphs are used to represent data that has been collected over a determined amount of time (for example, change in fish population in a week). Once the data has been collected and organized in an appropriate data table, a graph can be constructed. To construct a line graph, the following steps should be taken:

- Draw a horizontal line (x-axis) and a vertical line (y-axis) that meet at a right angle.
- Identify the independent (manipulated) variable and the dependent (responding) variable from the data.
  - The independent (manipulated) variable is written on the x-axis.
  - The dependent (responding) variable is written on the y-axis.
  - Include appropriate units of measurement for each variable.
- Look at the range of data (lowest and highest) to determine the *intervals* or *increments* (numbers on the axes) of the x-axis and the y-axis.
  - The increments do not need to be the same for both the x-axis and the y-axis, but should be consistent on either axis.
  - Label the point at the right angle as zero (0).
- Plot the data on the graph as matched pairs. For example, every independent (manipulated) variable number will have a corresponding dependent (responding) variable number.
- Connect the points on the line graph.
- Write an appropriate title for the graph that contains the names of both variables.

NOTE TO TEACHER: A mnemonic device that can be used to teach the appropriate locations of the variables on a graph is DRY MIX.

- DRY represents Dependent-Responding-Y-axis.
- MIX represents Manipulated-Independent-X-axis.

It is not essential for students to construct circle graphs.

Assessment Guidelines:
The objective of this indicator is to *construct* a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables; therefore, the primary focus of assessment should be to create a line graph with the proper placement of the variables and data from the investigation. However, appropriate assessments should also require students to *identify* the correct placement of variables on line graphs; *identify* the parts of a line graph; *recognize* appropriate increments for a line graph of recorded data; *recognize* appropriate title for recorded data; *match* appropriate title to a given line graph; *exemplify* appropriate line graphs from recorded data; or *compare* line graphs with recorded data.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.6 Evaluate results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form.
Taxonomy Level: 5.2-B Evaluate Conceptual Knowledge

Previous/Future knowledge: In 2nd grade (2-1.3), students represented and communicated simple data and explanations through drawings, tables, pictographs, bar graphs, and oral and written language. In 3rd grade (3-1.7), students explained why similar investigations might produce different results. In 4th grade (4-1.6), students constructed and interpreted diagrams, tables, and graphs made from recorded measurements and observations. In 7th grade, students will generate questions that can be answered through scientific investigation (7-1.2) and will critique a conclusion drawn from a scientific investigation (7-1.6). In 8th grade, students will construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation (8-1.3) and will generate questions for further study on the basis of prior investigations (8-1.4).

It is essential for students to know that data from an investigation can be organized in tables and graphs so that a valid conclusion can be drawn.

- A *valid conclusion* is an explanation based on observations and collected data that states the relationship between the independent (manipulated) and dependent (responding) variables.
- Inferences are sometimes needed to help form a valid conclusion.
  - An *inference* is an explanation or interpretation of an observation based on prior experiences or supported by observations made in the investigation.
- A conclusion statement should include a comparison of the results of the investigation to the hypothesis.
- Communicating the results of an experiment (in diagrams or graphs) allows others to evaluate and understand the investigation.
- The conclusion can be presented in written form and/or orally.

It is not essential for students to generate a new question or new hypothesis from the results of an investigation.

Assessment Guidelines:
One objective of this indicator is to *evaluate* results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form; therefore, the primary focus of assessment should be to make judgments about an investigation based on the results. However, appropriate assessments should also require students to *recognize* a valid conclusion for a given investigation; *compare* data recorded with the steps in the investigation; *identify* and *exemplify* observations and inferences used to formulate a valid conclusion; *compare* the conclusion with the hypothesis; *explain* the results of an investigation; or *identify* graphs which correctly represent given data.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.7 Use a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings.
Taxonomy Level:

Previous/Future knowledge: This is the first time that the technological design process has been introduced. In 6th grade (6-1.4), students will use a technological design process to plan and produce a solution to a problem or a product (including identifying a problem, designing a solution or a product, implementing the design, and evaluating the solution or the product). In high school Physical Science (PS-1.8), students will compare the processes of scientific investigation and technological design.

It is essential for students to know that *technology* is any tool or process designed to help society in some way. Technology applies scientific knowledge in order to develop a solution to a problem or create a product to help meet human needs. Technology is usually developed because there is a need or a problem that needs to be solved. *Technological design* is the process of using scientific knowledge and processes to develop technology (such as solutions to a problem or a new or improved product). Steps in the technological design process include:

- *Identifying a problem or need*
  - Research and gather information on what is already known about the problem or need
- *Designing a solution or a product*
  - Generate ideas on possible solutions or products
- *Implementing the design*
  - Build and test a solution or a product
- *Evaluating the solution or the product*
  - Determine if the solution or product solved the problem

The steps of the design can be communicated using descriptions, models, and drawings.

- A *scientific model* is an idea that allows us to create explanations of how the something may work. Models can be physical or mental.

NOTE TO TEACHER: Students in 5th grade need to know the steps used in a simple technological design, but do not have to carry out the steps to create the product or solution. However, to conceptualize this process, the implementation of the steps would be helpful.

It is not essential for students to compare the processes of a controlled scientific investigation and the technological design process or evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

Assessment Guidelines:
The objective of this indicator is to *use* a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings; therefore, the primary focus of assessment should be to apply the procedures for a simple technological design process as listed in the indicator. However, appropriate assessments should also require students to *illustrate* the design process through words, pictures, or diagrams; *summarize* the process of technological design; *identify* the steps of technological design; or *match* a specific solution or product to a specific need or problem.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.8 Use appropriate safety procedures when conducting investigations.
Taxonomy Level: 3.2-C Apply Procedural Knowledge

Previous/Future knowledge: In all grades students use appropriate safety procedures when conducting investigations that are appropriate to their grade, tools, and types of investigations.

It is essential for students to know that care should be taken when conducting a science investigation to make sure that everyone stays safe.

Safety procedures to use when conducting simple science investigations may be

- Always wear appropriate safety equipment such as goggles or an apron when conducting an investigation.
- Be careful with sharp objects and glass. Only the teacher should clean up broken glass.
- Do not put anything in the mouth unless instructed by the teacher.
- Follow all directions for completing the science investigation.
- Follow proper handling of animals and plants in the classroom.
- Keep the workplace neat. Clean up when the investigation is completed.
- Practice all of the safety procedures associated with the activities or investigations conducted.
- Tell the teacher about accidents or spills right away.
- Use caution when mixing solutions.
- Use caution when working with heat sources and heated objects.
- Wash hands after each activity.

It is essential for students to use tools safely and accurately, including a timing device and a 10x magnifier, when conducting an investigation.

NOTE TO TEACHER (safety while working with students):

- Teacher materials have lists of "Safety Procedures" appropriate for the suggested activities. Students should be able to describe and practice all of the safety procedures associated with the activities they conduct.
- Most simple investigations will not have any risks, as long as proper safety procedures are followed. Proper planning will help identify any potential risks and therefore eliminate any chance for student injury or harm.
- Teachers should review the safety procedures before doing an activity.
- Lab safety rules may be posted in the classroom and/or laboratory where students can view them. Students should be expected to follow these rules.
- A lab safety contract is recommended to notify parents/guardians that classroom science investigations will be hands-on and proper safety procedures will be expected. These contracts should be signed by the student and the parents or guardians and kept on file to protect the student, teacher, school, and school district.
- In the event of a laboratory safety violation or accident, documentation in the form of a written report should be generated. The report should be dated, kept on file, include a signed witness statement (if possible) and be submitted to an administrator.
- Materials Safety Data Sheets (MSDS) will be found in kits if necessary.
- For further training in safety guidelines, you can obtain the SC Lab Safety CD or see the Lab Safety flip-chart (CD with training or flip-chart available from the SC Department of Education).

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

It is not essential for students to go beyond safety procedures appropriate to the kinds of investigations that are conducted in a fifth grade classroom.

Assessment Guidelines:
The objective of this indicator is to *use* appropriate safety procedures when conducting investigations**;** therefore, the primary focus of assessment should be to apply correct procedures that would be needed to conduct a science investigation. However, appropriate assessments should also require students to *identify* safety procedures that are needed while conducting an investigation; or *recognize* when safety procedures are being used.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.1 Identify questions suitable for generating a hypothesis.
Taxonomy Level: 1.1-C Remember Procedural Knowledge

Previous/Future knowledge: In 3rd grade (3-1.3), students generated questions such as "what if?" or "how?" about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation. In 4th grade (4-1.3), students summarized the characteristics of a simple scientific investigation that represent a fair test (including asking a question that identifies a problem). Students have not been introduced to the concept of hypothesis prior to this grade. In 7th grade (7-1.2), students will generate questions that can be answered through scientific investigation. In 8th grade (8-1.4), students will generate questions for further study on the basis of prior investigations.

It is essential for students to know that only *testable questions*, which are used to test one variable, are suitable for scientific investigations. The question should include the relationship between the *independent* (manipulated) variable and *dependent* (responding) variable. For example, the following are testable questions:

- How does the amount of space affect the population of fish in a pond?
  - The independent (manipulated) variable is size of the pond.
  - The dependent (responding) variable is the population of fish in the pond.
- What is the effect of slope of the land on the amount of soil erosion?
  - The independent (manipulated) variable is the slope of the land.
  - The dependent (responding) variable is the amount of soil erosion.
- How does stirring affect the rate that salt dissolves in water?
  - The independent (manipulated) variable is the stirring.
  - The dependent (responding) variable is the time to dissolve.

It is also essential for students to know that a prediction about the relationship between variables is formed from the testable question. This prediction is called a *hypothesis*.

- All controlled investigations should have a hypothesis.
- A hypothesis can be stated positively or negatively. For example,
  - The smaller the pond, the smaller the population of fish. (negative statement)
  - The greater the slope of the land, the more soil erosion will be observed. (positive statement)
  - The faster the stirring, the shorter amount of time it will take to dissolve the salt. (positive statement)
- A hypothesis can also be stated as a cause-and-effect ("If…then,…") statement. For example, "If there is more food available, then the population of fish will increase."
- The experiment is conducted to support or not support a hypothesis. If the hypothesis is not supported by the experiment, it can still be used to help rule out some other ideas.

NOTE TO TEACHER: In 4th grade (4-1.3), students generated predictions to the testable questions. In 5th grade, students will continue to generating these predictions, but use the term hypothesis.

It is not essential for students to conduct an investigation for every question they generate or generate questions based on prior investigations.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Assessment Guidelines:

The objective of this indicator is to *identify* questions suitable for generating a hypothesis; therefore, the primary focus of assessment should be to recognize a question that leads to a hypothesis. However, appropriate assessments should also require students to *recognize* an appropriate hypothesis from a testable question or investigation; *recognize* that a testable question should have a manipulated and responding variable; or *identify* the manipulated and responding variables in a question.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.2 Identify independent (manipulated), dependent (responding), and controlled variables in an experiment.

Taxonomy Level: 1.1-B Remember Conceptual Knowledge

Previous/Future knowledge: In 4th grade (4-1.5), students recognized the correct placement of variables on a line graph. In 7th grade (7-1.5), students will explain the relationship between independent and dependent variables in controlled a scientific investigation through the use of appropriate graphs, tables, and charts.

It is essential for students to know that in an experiment there are three types of variables.

- The manipulated variable (changed or tested in the experiment) is also called the *independent variable*.
- The variables that are kept the same, or unchanged, in the experiment are called the *controlled variables*.
- The responding variable (the result of, or response to, the manipulated variable) is also called the *dependent variable*.

For example, a student conducts an experiment to test whether changing the surface of the floor will increase the distance a toy car will roll. The student uses carpet, rubber mat, and the floor. When the car is pushed with the same amount of force on each surface, the student finds that it rolls farther on the floor than the carpet or rubber mat. The independent (manipulated) variable is the surface of the floor. The controlled variables are the size of the carpet and rubber mat, the same toy car, and the force with which the car is pushed. The dependent (responding) variable is the distance the car rolled.

NOTE TO TEACHER: Students should be using both terms independent (manipulated) and dependent (responding) when describing variables.

Assessment Guidelines:

The objective of this indicator is to *identify* variables in an experiment; therefore, the primary focus of assessment should be to recognize a variable as independent (manipulated), dependent (responding), and controlled in an experiment.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.
Taxonomy Level: 6.2 and 3.1 Create and Apply Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-1.3), students carried out simple scientific investigations when given clear directions. In 2nd grade (2-1.1), students carried out simple scientific investigations to answer questions about familiar objects and events. In 4th grade, students summarized the characteristics of a simple scientific investigation that represent a fair test (including a question that identifies the problem, a prediction that indicates a possible outcome, a process that tests one manipulated variable at a time, and results that are communicated and explained) (4-1.3) and constructed and interpreted diagrams, tables, and graphs made from recorded measurements and observations (4-1.6). In 7th grade, students will explain the reasons for testing one independent variable at a time in a controlled scientific investigation (7-1.3) and will explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation (7-1.4). In 8th grade, students will design a controlled scientific investigation (8-1.1) and will explain the importance of and requirements for replication of scientific investigations (8-1.5).

It is essential for students to know that a *controlled scientific investigation* determines the effect of an independent variable in an experiment, when all other variables are controlled. Every controlled scientific investigation provides information. This information is called *data*. Data includes both scientific observations and inferences.

- A *scientific observation* is gained by carefully identifying and describing properties using the five senses or scientific tools and can be classified as *quantitative* or *qualitative*.
  - Quantitative observations are observations that use numbers (amounts) or measurements (including the unit label) or observations that make relative comparisons, such as more than, all, less than, few, or none.
  - Qualitative observations are observations that are made using only the senses and refer to specific properties.
- An *inference* is an explanation or interpretation of an observation based on prior experiences or supported by observations made in the investigation. They are not final explanations of the observation. There may be several logical inferences for a given observation. There is no way to be sure which inference best explains the observation without further investigation.

In order to design a *controlled scientific investigation* some or all of the following steps should be included:

- Identify a testable question (tests one variable) that can be investigated
- Research information about the topic
- State the hypothesis as a predicted answer to the question, what may be the possible outcome of the investigation
- Design an experiment to test the hypothesis, controlling all variables except the independent (manipulated) variable
  - Plan for independent (manipulated) and dependent (responding) variables
  - Plan for factors that should be held constant (controlled variables)
  - List the materials needed to conduct the experiment
  - List the procedures to be followed
  - Plan for recording, organizing and analyzing data
- Conduct the experiment and record data (observations) in tables, graphs, or charts

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

- Analyze the data in the tables, graphs, or charts to figure out what the data means (describe the relationship between the variables)
- Compare the results to the hypothesis and write a conclusion that will support or not support the hypothesis based on the recorded data
- Communicate the results to others

It is essential for students to conduct a controlled scientific investigation after planning the experimental design.

- Appropriate tools should be selected and used.
- Appropriate safety precautions should be taken when conducting the investigation.
- Measurements and observations should be recorded accurately in the appropriate table, chart, or graph.

It is not essential for students to design or conduct an experiment that includes a controlled set-up (7-1.3).

Assessment Guidelines:

One objective of this indicator is to *plan* controlled scientific investigations, manipulating one variable at a time; therefore, the primary focus of assessment should be to design the procedures for completing a scientific investigation where one variable is manipulated. However, appropriate assessments should also require students to *recognize* steps appropriate for conducting a controlled investigation; *detect* inappropriate steps in a given investigation; or *organize* the results of the investigation in tables or charts.

Another objective of this indicator is to *conduct* controlled scientific investigations, manipulating one variable at a time; therefore, the primary focus of assessment should be to carry out the procedures for completing a scientific investigation where one variable is manipulated. However, appropriate assessments should also require students to *summarize* the steps of a controlled investigation; *use* appropriate tools and safety precautions when conducting the investigation; *identify* appropriate tools for an investigation; *recognize* measurements and observations that are accurate and inaccurate in an investigation.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.4 Use appropriate tools and instruments (including a timing device and a 10x magnifier) safely and accurately when conducting a controlled scientific investigation.
Taxonomy Level: 3.2-C Apply Procedural Knowledge

Previous/future knowledge: In previous grades, students used magnifiers and eyedroppers (K-1.2), rulers (1-1.2), thermometers, rain gauges, balances, and measuring cups (2-1.2), beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes (3-1.5), and a compass, an anemometer, mirrors, and a prism (4-1.2) safely, accurately, and appropriately. In future grades, students will continue to use these tools, when appropriate, as well as use new tools when collecting scientific data. A complete list of tools can be found in Appendix A of the Academic Standards.

It is essential for students to know that different instruments or tools are needed to collect different kinds of data.

- A *timing device* is an instrument used to measure time.
  - An example of a timing device is a stop watch or clock with a second hand.
  - Time is measured in seconds (s), minutes (min), hours (hr), and days.
- A *10x magnifier* is a tool that is used to enlarge objects or see details.
  - Objects seen through a 10x magnifier look ten times larger than they do with the unaided eye.

It is essential for students to use care when handling these tools when gathering data.

- Care should be taken not to break or drop the timing device or magnifier.

It is also essential for students to use tools from previous grade levels that are appropriate to the content of this grade level such as eyedroppers, magnifiers, rulers (measuring to centimeters or millimeters), pan balances (measuring in grams), thermometers (measuring in ^{o}F and ^{o}C), beakers (measuring liters or milliliters), forceps/tweezers, graduated cylinders (measuring in milliliters), graduated syringes (measuring in milliliters), meter sticks and meter tapes (measuring in meters, centimeters, or millimeters), or compasses to gather data. Other units of measurement that students should be familiar with are kilograms (mass) or kilometers (distance).

NOTE TO TEACHER: See information in previous grades regarding how to use each tool.
All temperature readings during investigations will be taken using the Celsius scale unless the data refers to weather when the Fahrenheit scale is used.

It is not essential for students to know how to use spring scales or a more complex magnifier such as a microscope. Tools from previous grades that are not appropriate to the content of this grade level are not essential; however, these terms may be used as distracters (incorrect answer options) for assessment, for example measuring cups, rain gauges, tuning forks, anemometers, mirrors (plane/flat), or prisms. Students do not need to convert measurements from English to metric or metric to English.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Assessment Guidelines:

The objective of this indicator is to *use* tools safely, accurately, and appropriately when gathering data; therefore, the primary focus of assessment should be to apply correct procedures to the use of a timing device, a 10x magnifier, and other tools essential to the grade level that would be needed to conduct a science investigation. However, appropriate assessments should also require students to *identify* appropriate uses for a timing device, or a 10x magnifier; *illustrate* the appropriate tool for an investigation using pictures, diagrams, or words; *recall* how to accurately determine the measurement from the tool; or *recognize* ways to use science tools safely, accurately, and appropriately.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.5 Construct a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables.
Taxonomy Level: 6.3-C Create Procedural Knowledge

Previous/Future knowledge: In 4th grade, students recognized the correct placement of variables on a line graph (4-1.5) and constructed and interpreted diagrams, tables, and graphs made from recorded measurements and observations (4-1.6). In 7th grade (7-1.5), students will explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.

It is essential for students to know that line graphs are used to represent data that has been collected over a determined amount of time (for example, change in fish population in a week). Once the data has been collected and organized in an appropriate data table, a graph can be constructed. To construct a line graph, the following steps should be taken:

- Draw a horizontal line (x-axis) and a vertical line (y-axis) that meet at a right angle.
- Identify the independent (manipulated) variable and the dependent (responding) variable from the data.
  - The independent (manipulated) variable is written on the x-axis.
  - The dependent (responding) variable is written on the y-axis.
  - Include appropriate units of measurement for each variable.
- Look at the range of data (lowest and highest) to determine the *intervals* or *increments* (numbers on the axes) of the x-axis and the y-axis.
  - The increments do not need to be the same for both the x-axis and the y-axis, but should be consistent on either axis.
  - Label the point at the right angle as zero (0).
- Plot the data on the graph as matched pairs. For example, every independent (manipulated) variable number will have a corresponding dependent (responding) variable number.
- Connect the points on the line graph.
- Write an appropriate title for the graph that contains the names of both variables.

NOTE TO TEACHER: A mnemonic device that can be used to teach the appropriate locations of the variables on a graph is DRY MIX.

- DRY represents Dependent-Responding-Y-axis.
- MIX represents Manipulated-Independent-X-axis.

It is not essential for students to construct circle graphs.

Assessment Guidelines:
The objective of this indicator is to *construct* a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables; therefore, the primary focus of assessment should be to create a line graph with the proper placement of the variables and data from the investigation. However, appropriate assessments should also require students to *identify* the correct placement of variables on line graphs; *identify* the parts of a line graph; *recognize* appropriate increments for a line graph of recorded data; *recognize* appropriate title for recorded data; *match* appropriate title to a given line graph; *exemplify* appropriate line graphs from recorded data; or *compare* line graphs with recorded data.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.6 Evaluate results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form.
Taxonomy Level: 5.2-B Evaluate Conceptual Knowledge

Previous/Future knowledge: In 2nd grade (2-1.3), students represented and communicated simple data and explanations through drawings, tables, pictographs, bar graphs, and oral and written language. In 3rd grade (3-1.7), students explained why similar investigations might produce different results. In 4th grade (4-1.6), students constructed and interpreted diagrams, tables, and graphs made from recorded measurements and observations. In 7th grade, students will generate questions that can be answered through scientific investigation (7-1.2) and will critique a conclusion drawn from a scientific investigation (7-1.6). In 8th grade, students will construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation (8-1.3) and will generate questions for further study on the basis of prior investigations (8-1.4).

It is essential for students to know that data from an investigation can be organized in tables and graphs so that a valid conclusion can be drawn.

- A *valid conclusion* is an explanation based on observations and collected data that states the relationship between the independent (manipulated) and dependent (responding) variables.
- Inferences are sometimes needed to help form a valid conclusion.
  - An *inference* is an explanation or interpretation of an observation based on prior experiences or supported by observations made in the investigation.
- A conclusion statement should include a comparison of the results of the investigation to the hypothesis.
- Communicating the results of an experiment (in diagrams or graphs) allows others to evaluate and understand the investigation.
- The conclusion can be presented in written form and/or orally.

It is not essential for students to generate a new question or new hypothesis from the results of an investigation.

Assessment Guidelines:
One objective of this indicator is to *evaluate* results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form; therefore, the primary focus of assessment should be to make judgments about an investigation based on the results. However, appropriate assessments should also require students to *recognize* a valid conclusion for a given investigation; *compare* data recorded with the steps in the investigation; *identify* and *exemplify* observations and inferences used to formulate a valid conclusion; *compare* the conclusion with the hypothesis; *explain* the results of an investigation; or *identify* graphs which correctly represent given data.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.7 Use a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings.
Taxonomy Level:

Previous/Future knowledge: This is the first time that the technological design process has been introduced. In 6th grade (6-1.4), students will use a technological design process to plan and produce a solution to a problem or a product (including identifying a problem, designing a solution or a product, implementing the design, and evaluating the solution or the product). In high school Physical Science (PS-1.8), students will compare the processes of scientific investigation and technological design.

It is essential for students to know that *technology* is any tool or process designed to help society in some way. Technology applies scientific knowledge in order to develop a solution to a problem or create a product to help meet human needs. Technology is usually developed because there is a need or a problem that needs to be solved. *Technological design* is the process of using scientific knowledge and processes to develop technology (such as solutions to a problem or a new or improved product). Steps in the technological design process include:

- *Identifying a problem or need*
  - Research and gather information on what is already known about the problem or need
- *Designing a solution or a product*
  - Generate ideas on possible solutions or products
- *Implementing the design*
  - Build and test a solution or a product
- *Evaluating the solution or the product*
  - Determine if the solution or product solved the problem

The steps of the design can be communicated using descriptions, models, and drawings.

- A *scientific model* is an idea that allows us to create explanations of how the something may work. Models can be physical or mental.

NOTE TO TEACHER: Students in 5th grade need to know the steps used in a simple technological design, but do not have to carry out the steps to create the product or solution. However, to conceptualize this process, the implementation of the steps would be helpful.

It is not essential for students to compare the processes of a controlled scientific investigation and the technological design process or evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

Assessment Guidelines:
The objective of this indicator is to *use* a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings; therefore, the primary focus of assessment should be to apply the procedures for a simple technological design process as listed in the indicator. However, appropriate assessments should also require students to *illustrate* the design process through words, pictures, or diagrams; *summarize* the process of technological design; *identify* the steps of technological design; or *match* a specific solution or product to a specific need or problem.

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

5-1.8 Use appropriate safety procedures when conducting investigations.
Taxonomy Level: 3.2-C Apply Procedural Knowledge

Previous/Future knowledge: In all grades students use appropriate safety procedures when conducting investigations that are appropriate to their grade, tools, and types of investigations.

It is essential for students to know that care should be taken when conducting a science investigation to make sure that everyone stays safe.

Safety procedures to use when conducting simple science investigations may be

- Always wear appropriate safety equipment such as goggles or an apron when conducting an investigation.
- Be careful with sharp objects and glass. Only the teacher should clean up broken glass.
- Do not put anything in the mouth unless instructed by the teacher.
- Follow all directions for completing the science investigation.
- Follow proper handling of animals and plants in the classroom.
- Keep the workplace neat. Clean up when the investigation is completed.
- Practice all of the safety procedures associated with the activities or investigations conducted.
- Tell the teacher about accidents or spills right away.
- Use caution when mixing solutions.
- Use caution when working with heat sources and heated objects.
- Wash hands after each activity.

It is essential for students to use tools safely and accurately, including a timing device and a 10x magnifier, when conducting an investigation.

NOTE TO TEACHER (safety while working with students):

- Teacher materials have lists of "Safety Procedures" appropriate for the suggested activities. Students should be able to describe and practice all of the safety procedures associated with the activities they conduct.
- Most simple investigations will not have any risks, as long as proper safety procedures are followed. Proper planning will help identify any potential risks and therefore eliminate any chance for student injury or harm.
- Teachers should review the safety procedures before doing an activity.
- Lab safety rules may be posted in the classroom and/or laboratory where students can view them. Students should be expected to follow these rules.
- A lab safety contract is recommended to notify parents/guardians that classroom science investigations will be hands-on and proper safety procedures will be expected. These contracts should be signed by the student and the parents or guardians and kept on file to protect the student, teacher, school, and school district.
- In the event of a laboratory safety violation or accident, documentation in the form of a written report should be generated. The report should be dated, kept on file, include a signed witness statement (if possible) and be submitted to an administrator.
- Materials Safety Data Sheets (MSDS) will be found in kits if necessary.
- For further training in safety guidelines, you can obtain the SC Lab Safety CD or see the Lab Safety flip-chart (CD with training or flip-chart available from the SC Department of Education).

Scientific Inquiry

5-1 The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

It is not essential for students to go beyond safety procedures appropriate to the kinds of investigations that are conducted in a fifth grade classroom.

Assessment Guidelines:
The objective of this indicator is to *use* appropriate safety procedures when conducting investigations**;** therefore, the primary focus of assessment should be to apply correct procedures that would be needed to conduct a science investigation. However, appropriate assessments should also require students to *identify* safety procedures that are needed while conducting an investigation; or *recognize* when safety procedures are being used.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.1 Recall the cell as the smallest unit of life and identify its major structures (including cell membrane, cytoplasm, nucleus, and vacuole).
Taxonomy level: 1.1 and 1.2-A Remember Factual Knowledge

Previous/Future knowledge: This is the first time students have been introduced to cells. In 7th grade (7-2.1), students will summarize the functions of the components of plant and animal cells, including the cell wall, the cell membrane, the nucleus, chloroplasts, mitochondria, and vacuoles).

It is essential for students to know that all organisms are made of cells.

- The *cell* is the smallest unit of living material having major structures within it allowing it to live.
- Some kinds of organisms are just one cell. This single cell is the organism's entire body.
- Many organisms are made of more than one cell.

Cells vary in size, but all cells contain these major structures:
Cell membrane

- The soft, flexible outside covering of a cell that controls what comes in and out of a cell.

Cytoplasm

- The gel-like fluid that fills most of a cell. The other organelles are found in the cytoplasm.

Nucleus

- A small structure that controls everything the cell does.

Vacuole(s)

- Are storage spaces in the cell.
- They can hold water and other nutrients that the cell needs.
- They can also store wastes until the cell can get rid of it.

NOTE TO TEACHER: It is appropriate to introduce the mitochondria (where energy is made) as a major structure common to all cells.

It is not essential for students to know the other parts of a cell (mitochondria, cell wall, or chloroplasts), to compare plant and animal cells, or to know various types of cells found in the body (blood, muscle, nerve).

Assessment Guidelines:
One objective of this indicator is to *recall* the cell as the smallest unit of life; therefore, the primary focus of assessment should be to remember that the smallest unit of all organisms is the cell.

Another objective of this indicator is to *identify* the major structures of a cell; therefore, the primary focus of assessment should be to *recall* these major structures (including cell membranes, a nucleus, vacuoles, and cytoplasm) in cells.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.2 Summarize the composition of an ecosystem, considering both biotic factors (including populations, to the level of microorganisms, and communities) and abiotic factors.

Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st and 2nd grade, students explained how distinct environments of the world support different plants (1-2.5) or animals (2-2.3). In 3rd grade (3-2.3), students recalled the characteristics of a habitat that allowed organisms to survive there. In 4th grade (4-2.2), students explained how the characteristics of distinct environments influence the variety of organism there. In 7th grade (7-4), students will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environment.

It is essential for students to know that an *ecosystem* contains all of the organisms and their nonliving surrounding environment that contribute to the functioning of the ecosystem. An example of an ecosystem is an estuary, including all of the animals, plants, water, soil, air, and sunlight present and the interactions among them.

- The living parts of the ecosystem are called the *biotic factors* and include populations and communities of organisms.
- The nonliving parts of the ecosystem are called the *abiotic factors* and include the temperature, water, soil, air, and sunlight.

The living organisms in an environment can be grouped in two ways:
Population

- All members of one kind of organism that live in a particular area.
- Some examples of a population may be all of the white-tailed deer in a forest, all rainbow trout in a stream, or all of the bald cypress trees in the swamp.
- *Microorganisms* are living things that can be a single-celled or multi-celled organism that is too small to be seen without at least a 10x magnifier.

NOTE TO TEACHER: Students only need to know microorganisms as part of a community, not individual populations.

Communities

- A group of different populations of organisms.
- Some examples of communities are all of the squirrels, acorn trees, and grass in a park; all of the microorganisms in a pond; or all of the cacti, rattlesnakes, and scorpions in the desert.

It is not essential for students to know the types of microorganisms (paramecium, euglena, and amoeba).

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

Assessment Guidelines:

The objective of this indicator is to *summarize* the composition of an ecosystem; therefore, the primary focus of assessment should be to generalize major points about the biotic and abiotic components of an ecosystem. However, appropriate assessments should also require students to *exemplify* or *illustrate* components of an ecosystem; *classify* parts of an ecosystem as biotic or abiotic; *identify* the organizational parts of an ecosystem; or *classify* organisms as populations or communities.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.3 Compare the characteristics of different ecosystems (including estuaries/salt marshes, oceans, lakes and ponds, forests, and grasslands).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have previously learned about habitats and distinct ecosystems in 1st, 2nd, 3rd and 4th grade. They have learned about the characteristics of different environments and how changes can occur. Students have previously learned about rivers and streams, tropical rain forests, deserts and polar regions in 4th grade (4-2.2).

It is essential that students to know that there are different types of ecosystems (terrestrial and aquatic). These ecosystems can be divided into two types according to their characteristics:

Terrestrial

- Land-based ecosystems include forests and grasslands.
  - *Forests* have many trees (with needles or with leaves), shrubs, grasses and ferns, and a variety of animals. They usually get more rain than grasslands. Temperatures in the forests may vary depending on where the forest is located.
  - *Grasslands* have fertile soil and are covered with tall grasses. They usually get a medium amount of rain, but less than forests. Temperatures may also vary depending on where the grassland is located. Some examples of animals that live in the grasslands are prairie dogs, bison, and grasshoppers.

Aquatic

- Water-based ecosystems may be fresh water (lakes and ponds) or saltwater (oceans, estuaries and saltwater marshes).
  - *Lakes* and *ponds* are bodies of freshwater that are surrounded by land. Ponds are usually shallower than lakes and the temperature of the water usually stays the same from top to bottom. Plants and algae usually grow along the edges where the water is shallow. Some examples of animals may be different types of fish, amphibians, ducks, turtles, or beavers.
  - *Oceans* are large bodies of saltwater divided by continents. Oceans have many types of ecosystems depending on the conditions (sunlight, temperature, depth, salinity) of that part of the ocean.
    - Most organisms live where the ocean is shallow (from the shoreline to the continental shelf) because sunlight can reach deep and the water is warm making food is abundant. Some examples of organisms that live in the shallow ocean may be drifters (jellyfish or seaweed), swimmers (fish), crawlers (crabs), and those anchored to the ocean floor (corals).
    - Some organisms live in the open ocean, near the surface or down to the deep ocean bottom. Plankton float in the upper regions of the water. Some organisms swim to the surface to find food or for air (whales, turtles, sharks) while others stay live closer to the bottom (certain fish, octopus, tubeworms).

- *Estuaries* are found where the freshwater rivers meet the oceans. They are saltier than a river, but not as salty as the ocean. The amount of salt (salinity) changes as the tides come in and out. Estuaries contain *salt marshes* with grasses and marsh plants adapted to this changing water. Some examples of animals that live in the estuaries/salt marshes may be crabs, shrimp, birds such as blue heron and egrets, and muskrats.

It is not essential for students to know the different types of forests (coniferous, deciduous, rainforests), to name the specific ocean zones, or the locations of these environments on a map. Students have already studied rainforests, rivers and streams, polar regions, and deserts.

Assessment Guidelines:
The objective of this indicator is to *compare* characteristics of different ecosystems; therefore, the primary focus of assessment should be to for students to detect similarities and differences between aquatic ecosystems and between terrestrial ecosystems. However, appropriate assessments should also require students to *identify* an ecosystem based on its description; or *exemplify* characteristics of each ecosystem.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.4 Identify the roles of organisms as they interact and depend on one another through food chains and food webs in an ecosystem, considering producers and consumers (herbivores, carnivores, and omnivores), decomposers (microorganisms, termites, worms, and fungi), predators and prey, and parasites and hosts.
Taxonomy level: 1.1-B Remember Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-2.5), students summarized the organization of simple food chains (including the roles of producers, consumers, and decomposers). In 7th grade (7-4.2), students will illustrate the flow of energy in food chains, food webs and energy pyramids.

It is essential for students to know that all organisms need energy to live and grow. This energy is obtained from food. The role an organism serves in an ecosystem can be described by the way in which it gets its energy.

Producers
- Plants are called producers because they are able to use light energy from the Sun to produce food (sugar) from carbon dioxide in the air and water.

Consumers
- Animals cannot make their own food so they must eat plants and/or other animals.
- They are called consumers.
- There are three main groups of consumers.
  - Animals that eat only plants are called *herbivores*.
  - Animals that eat only animals are called *carnivores*.
  - Animals that eat both animals and plants are called *omnivores*.

Decomposers
- Consumers (including microorganisms, termites, worms, and fungi) that get the energy they need by breaking down dead or decaying matter.
- These decomposers speed up the decaying process that releases nutrients back into the food chain for use by plants.

One way to show how energy is passed through an ecosystem is through a food chain.
- A *food chain* is a series of plants and animals in which each organism is a source of food (energy) for the next in the series.
- In a typical food chain, plants use the Sun's energy to make their own food and then are eaten by one kind of animal which in turn is eaten by another kind of animal.
- Most organisms are part of more than one food chain and eat more than one kind of food in order to meet their energy requirements.
- Interconnected food chains form a *food web*.
- Most food chains have no more than six organisms.
- There cannot be too many links in a single food chain because the animals at the end of the chain would not get enough food (energy) to stay alive.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

- The role of an organism can be identified by its placement on the food chain.
- Decomposers are not typically noted on a food chain; they will break down any organism on the food chain when it dies.

An example of a grassland food chain:

Sun →	**Grass** →	**Grasshopper** →	**Toad** →	**Snake** →	**Hawk** →
	Producer	Consumer	Consumers		

Note that the arrows are drawn from *food source* → to *food consumer*

Organisms can also be identified based on how they interact with other organisms.

- *Predators* are animals that hunt and kill other animals for food.
- *Prey* are animals that are hunted and killed as food for other animals.
- A *parasite* is an organism that spends a significant portion of its life in or on a living *host* organism usually causing harm to the host without immediately killing it.
- *Hosts* are organisms or cells that serve as a home or a source of food for a parasite.

It is not essential for students to identify trophic levels found in a food chain or web, identify energy pyramids, or know other relationships between organisms (such as mutualism, commensalism, or symbiosis).

Assessment Guidelines:
The objective of this indicator is to *identify* roles of organisms in an ecosystem; therefore, the primary focus of assessment should be to recognize the roles of organism in a food chain or a food web. However, appropriate assessments should also require students to *recall* the roles of producers, consumers (including herbivores, carnivores, and omnivores), and decomposers; *recognize* from drawings or diagrams the components of a food chain or food web; or *recognize* the roles of predators and prey as well as parasites and host.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.5 Explain how limiting factors (including food, water, space, and shelter) affect populations in ecosystems.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have previously learned about the needs of living things and the interdependence between animals and plants in their habitats (3-2), but they have not explored the concept of limiting factors. In 7th grade (7-4.3), students will explain the interactions between various environmental changes and limiting factors.

It is essential for students to know an ecosystem only has a certain amount food, water, space, and shelter to support a certain number of organisms.

- The relationship between numbers of organisms and the resources available in an ecosystem is often described as the *balance of nature*.
- A condition or resource that keeps a population at a certain size is known as a *limiting factor*.
- If any of the limiting factors change, animal and plant populations may also change.
- Some changes may cause a population to increase; others may cause a population to decrease.

Increases in population may result in overcrowding. Sometimes a population will grow too large for the environment to support. Some examples that may cause a population to increase may be:

- If there are more plants than usual in an area, populations of animals that eat that plants may increase.
- If the population of predators increases, the population of prey will decrease.
- If the population of prey increases, the population of predators will also increase because of the availability of food.

Other changes in limiting factors may cause a population to decrease. Some examples may be:

- If the water supply in an area decreases, the population that needs that water may decrease. Then the population of animals that eat that animal could decrease too.
- If trees are cut down, die because of disease or parasites, the population of the animals that use the trees for food or shelter will decrease.
- If organisms no longer have enough space to survive, they will either have to move or will die. This change in space may be due to human influence or natural hazards.

It is not essential for students to about carrying capacity or how a change in climate or how biotic factors affect population sizes.

Assessment Guidelines:
The objective of this indicator is to *explain* the how limiting factors affect populations in ecosystems; therefore, the primary focus of assessment should be for students to construct a cause-and-effect model that shows how populations change due to limiting factors. However, appropriate assessments should also require students to *recall* limiting factors; *summarize* ways that limiting factors influence the balance of nature in an ecosystem; or *exemplify* ways that the abiotic factors affect populations of organisms.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.1 Recall the cell as the smallest unit of life and identify its major structures (including cell membrane, cytoplasm, nucleus, and vacuole).
Taxonomy level: 1.1 and 1.2-A Remember Factual Knowledge

Previous/Future knowledge: This is the first time students have been introduced to cells. In 7th grade (7-2.1), students will summarize the functions of the components of plant and animal cells, including the cell wall, the cell membrane, the nucleus, chloroplasts, mitochondria, and vacuoles).

It is essential for students to know that all organisms are made of cells.

- The *cell* is the smallest unit of living material having major structures within it allowing it to live.
- Some kinds of organisms are just one cell. This single cell is the organism's entire body.
- Many organisms are made of more than one cell.

Cells vary in size, but all cells contain these major structures:
Cell membrane

- The soft, flexible outside covering of a cell that controls what comes in and out of a cell.

Cytoplasm

- The gel-like fluid that fills most of a cell. The other organelles are found in the cytoplasm.

Nucleus

- A small structure that controls everything the cell does.

Vacuole(s)

- Are storage spaces in the cell.
- They can hold water and other nutrients that the cell needs.
- They can also store wastes until the cell can get rid of it.

NOTE TO TEACHER: It is appropriate to introduce the mitochondria (where energy is made) as a major structure common to all cells.

It is not essential for students to know the other parts of a cell (mitochondria, cell wall, or chloroplasts), to compare plant and animal cells, or to know various types of cells found in the body (blood, muscle, nerve).

Assessment Guidelines:
One objective of this indicator is to *recall* the cell as the smallest unit of life; therefore, the primary focus of assessment should be to remember that the smallest unit of all organisms is the cell.

Another objective of this indicator is to *identify* the major structures of a cell; therefore, the primary focus of assessment should be to *recall* these major structures (including cell membranes, a nucleus, vacuoles, and cytoplasm) in cells.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.2 Summarize the composition of an ecosystem, considering both biotic factors (including populations, to the level of microorganisms, and communities) and abiotic factors.

Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st and 2nd grade, students explained how distinct environments of the world support different plants (1-2.5) or animals (2-2.3). In 3rd grade (3-2.3), students recalled the characteristics of a habitat that allowed organisms to survive there. In 4th grade (4-2.2), students explained how the characteristics of distinct environments influence the variety of organism there. In 7th grade (7-4), students will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environment.

It is essential for students to know that an *ecosystem* contains all of the organisms and their nonliving surrounding environment that contribute to the functioning of the ecosystem. An example of an ecosystem is an estuary, including all of the animals, plants, water, soil, air, and sunlight present and the interactions among them.

- The living parts of the ecosystem are called the *biotic factors* and include populations and communities of organisms.
- The nonliving parts of the ecosystem are called the *abiotic factors* and include the temperature, water, soil, air, and sunlight.

The living organisms in an environment can be grouped in two ways:

Population

- All members of one kind of organism that live in a particular area.
- Some examples of a population may be all of the white-tailed deer in a forest, all rainbow trout in a stream, or all of the bald cypress trees in the swamp.
- *Microorganisms* are living things that can be a single-celled or multi-celled organism that is too small to be seen without at least a 10x magnifier.

NOTE TO TEACHER: Students only need to know microorganisms as part of a community, not individual populations.

Communities

- A group of different populations of organisms.
- Some examples of communities are all of the squirrels, acorn trees, and grass in a park; all of the microorganisms in a pond; or all of the cacti, rattlesnakes, and scorpions in the desert.

It is not essential for students to know the types of microorganisms (paramecium, euglena, and amoeba).

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

Assessment Guidelines:

The objective of this indicator is to *summarize* the composition of an ecosystem; therefore, the primary focus of assessment should be to generalize major points about the biotic and abiotic components of an ecosystem. However, appropriate assessments should also require students to *exemplify* or *illustrate* components of an ecosystem; *classify* parts of an ecosystem as biotic or abiotic; *identify* the organizational parts of an ecosystem; or *classify* organisms as populations or communities.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.3 Compare the characteristics of different ecosystems (including estuaries/salt marshes, oceans, lakes and ponds, forests, and grasslands).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have previously learned about habitats and distinct ecosystems in 1st, 2nd, 3rd and 4th grade. They have learned about the characteristics of different environments and how changes can occur. Students have previously learned about rivers and streams, tropical rain forests, deserts and polar regions in 4th grade (4-2.2).

It is essential that students to know that there are different types of ecosystems (terrestrial and aquatic). These ecosystems can be divided into two types according to their characteristics:

Terrestrial

- Land-based ecosystems include forests and grasslands.
  - *Forests* have many trees (with needles or with leaves), shrubs, grasses and ferns, and a variety of animals. They usually get more rain than grasslands. Temperatures in the forests may vary depending on where the forest is located.
  - *Grasslands* have fertile soil and are covered with tall grasses. They usually get a medium amount of rain, but less than forests. Temperatures may also vary depending on where the grassland is located. Some examples of animals that live in the grasslands are prairie dogs, bison, and grasshoppers.

Aquatic

- Water-based ecosystems may be fresh water (lakes and ponds) or saltwater (oceans, estuaries and saltwater marshes).
  - *Lakes* and *ponds* are bodies of freshwater that are surrounded by land. Ponds are usually shallower than lakes and the temperature of the water usually stays the same from top to bottom. Plants and algae usually grow along the edges where the water is shallow. Some examples of animals may be different types of fish, amphibians, ducks, turtles, or beavers.
  - *Oceans* are large bodies of saltwater divided by continents. Oceans have many types of ecosystems depending on the conditions (sunlight, temperature, depth, salinity) of that part of the ocean.
    - Most organisms live where the ocean is shallow (from the shoreline to the continental shelf) because sunlight can reach deep and the water is warm making food is abundant. Some examples of organisms that live in the shallow ocean may be drifters (jellyfish or seaweed), swimmers (fish), crawlers (crabs), and those anchored to the ocean floor (corals).
    - Some organisms live in the open ocean, near the surface or down to the deep ocean bottom. Plankton float in the upper regions of the water. Some organisms swim to the surface to find food or for air (whales, turtles, sharks) while others stay live closer to the bottom (certain fish, octopus, tubeworms).

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

- *Estuaries* are found where the freshwater rivers meet the oceans. They are saltier than a river, but not as salty as the ocean. The amount of salt (salinity) changes as the tides come in and out. Estuaries contain *salt marshes* with grasses and marsh plants adapted to this changing water. Some examples of animals that live in the estuaries/salt marshes may be crabs, shrimp, birds such as blue heron and egrets, and muskrats.

It is not essential for students to know the different types of forests (coniferous, deciduous, rainforests), to name the specific ocean zones, or the locations of these environments on a map. Students have already studied rainforests, rivers and streams, polar regions, and deserts.

Assessment Guidelines:
The objective of this indicator is to *compare* characteristics of different ecosystems; therefore, the primary focus of assessment should be to for students to detect similarities and differences between aquatic ecosystems and between terrestrial ecosystems. However, appropriate assessments should also require students to *identify* an ecosystem based on its description; or *exemplify* characteristics of each ecosystem.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.4 Identify the roles of organisms as they interact and depend on one another through food chains and food webs in an ecosystem, considering producers and consumers (herbivores, carnivores, and omnivores), decomposers (microorganisms, termites, worms, and fungi), predators and prey, and parasites and hosts.
Taxonomy level: 1.1-B Remember Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-2.5), students summarized the organization of simple food chains (including the roles of producers, consumers, and decomposers). In 7th grade (7-4.2), students will illustrate the flow of energy in food chains, food webs and energy pyramids.

It is essential for students to know that all organisms need energy to live and grow. This energy is obtained from food. The role an organism serves in an ecosystem can be described by the way in which it gets its energy.

Producers
- Plants are called producers because they are able to use light energy from the Sun to produce food (sugar) from carbon dioxide in the air and water.

Consumers
- Animals cannot make their own food so they must eat plants and/or other animals.
- They are called consumers.
- There are three main groups of consumers.
  - Animals that eat only plants are called *herbivores*.
  - Animals that eat only animals are called *carnivores*.
  - Animals that eat both animals and plants are called *omnivores*.

Decomposers
- Consumers (including microorganisms, termites, worms, and fungi) that get the energy they need by breaking down dead or decaying matter.
- These decomposers speed up the decaying process that releases nutrients back into the food chain for use by plants.

One way to show how energy is passed through an ecosystem is through a food chain.
- A *food chain* is a series of plants and animals in which each organism is a source of food (energy) for the next in the series.
- In a typical food chain, plants use the Sun's energy to make their own food and then are eaten by one kind of animal which in turn is eaten by another kind of animal.
- Most organisms are part of more than one food chain and eat more than one kind of food in order to meet their energy requirements.
- Interconnected food chains form a *food web*.
- Most food chains have no more than six organisms.
- There cannot be too many links in a single food chain because the animals at the end of the chain would not get enough food (energy) to stay alive.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

- The role of an organism can be identified by its placement on the food chain.
- Decomposers are not typically noted on a food chain; they will break down any organism on the food chain when it dies.

An example of a grassland food chain:

Sun →	**Grass** →	**Grasshopper** →	**Toad** →	**Snake** →	**Hawk** →
	Producer	Consumer	Consumers		

Note that the arrows are drawn from *food source* → to *food consumer*

Organisms can also be identified based on how they interact with other organisms.

- *Predators* are animals that hunt and kill other animals for food.
- *Prey* are animals that are hunted and killed as food for other animals.
- A *parasite* is an organism that spends a significant portion of its life in or on a living *host* organism usually causing harm to the host without immediately killing it.
- *Hosts* are organisms or cells that serve as a home or a source of food for a parasite.

It is not essential for students to identify trophic levels found in a food chain or web, identify energy pyramids, or know other relationships between organisms (such as mutualism, commensalism, or symbiosis).

Assessment Guidelines:
The objective of this indicator is to *identify* roles of organisms in an ecosystem; therefore, the primary focus of assessment should be to recognize the roles of organism in a food chain or a food web. However, appropriate assessments should also require students to *recall* the roles of producers, consumers (including herbivores, carnivores, and omnivores), and decomposers; *recognize* from drawings or diagrams the components of a food chain or food web; or *recognize* the roles of predators and prey as well as parasites and host.

Ecosystems: Terrestrial and Aquatic

5-2 Students will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

5-2.5 Explain how limiting factors (including food, water, space, and shelter) affect populations in ecosystems.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have previously learned about the needs of living things and the interdependence between animals and plants in their habitats (3-2), but they have not explored the concept of limiting factors. In 7th grade (7-4.3), students will explain the interactions between various environmental changes and limiting factors.

It is essential for students to know an ecosystem only has a certain amount food, water, space, and shelter to support a certain number of organisms.

- The relationship between numbers of organisms and the resources available in an ecosystem is often described as the *balance of nature*.
- A condition or resource that keeps a population at a certain size is known as a *limiting factor*.
- If any of the limiting factors change, animal and plant populations may also change.
- Some changes may cause a population to increase; others may cause a population to decrease.

Increases in population may result in overcrowding. Sometimes a population will grow too large for the environment to support. Some examples that may cause a population to increase may be:

- If there are more plants than usual in an area, populations of animals that eat that plants may increase.
- If the population of predators increases, the population of prey will decrease.
- If the population of prey increases, the population of predators will also increase because of the availability of food.

Other changes in limiting factors may cause a population to decrease. Some examples may be:

- If the water supply in an area decreases, the population that needs that water may decrease. Then the population of animals that eat that animal could decrease too.
- If trees are cut down, die because of disease or parasites, the population of the animals that use the trees for food or shelter will decrease.
- If organisms no longer have enough space to survive, they will either have to move or will die. This change in space may be due to human influence or natural hazards.

It is not essential for students to about carrying capacity or how a change in climate or how biotic factors affect population sizes.

Assessment Guidelines:
The objective of this indicator is to *explain* the how limiting factors affect populations in ecosystems; therefore, the primary focus of assessment should be for students to construct a cause-and-effect model that shows how populations change due to limiting factors. However, appropriate assessments should also require students to *recall* limiting factors; *summarize* ways that limiting factors influence the balance of nature in an ecosystem; or *exemplify* ways that the abiotic factors affect populations of organisms.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.1 Explain how natural processes (including weathering, erosion, deposition, landslides, volcanic eruptions, earthquakes, and floods) affect Earth's oceans and land in constructive and destructive ways.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.8), students illustrated changes in Earth's surface that are due to slow processes (including weathering, erosion, and deposition) and those changes due to rapid features (landslides, volcanic eruptions, floods and earthquakes). The primary focus was to provide examples of such changes. In 8th grade (8-3.6) the concept of plate tectonics, the movement of Earth's crustal plates, including its relationship to earthquakes and volcanoes, will be further studied.

It is essential for students to know Earth's oceans and land can be affected in constructive ways and destructive ways by natural processes.

Constructive
- Processes that create landforms (deposition, landslides, volcanic eruptions, floods)

Destructive
- Processes that destroy landforms (weathering, erosion, landslides, volcanic eruptions, earthquakes, floods)

Natural processes that can affect Earth's oceans and land include:

Weathering
- Weathering is a general term used to describe processes that break down rocks at or near the surface of the earth.
- Weathering can be either physical or chemical.
- These processes cause the surface of the earth to dissolve, decompose, and break into smaller pieces.
- Water is an important cause of weathering.
- Plants cause weathering when roots break apart rock.
- Changes in temperature can break rock, as well as ice forming inside cracks in the rock causing it to break even more.
- Anything that causes rocks to wear down or break apart is a cause of weathering.

Erosion
- Erosion is the movement of *sediments* and soil by wind, water, ice, and gravity.

Deposition
- Deposition is the dropping, or *depositing*, of sediments by water, wind, or ice.
- Deposition builds up new land on Earth's surface, like a delta at the end of a river or the pile up of a sand dune in the desert.
- Shells on the beach are deposition by ocean waves.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

Landslides

- Landslides are mass movements of land due to gravity.
- Landslides can cause buildings to fall, or power and gas lines to break.
- Landslides even occur on the continental slope in the ocean.

Volcanic eruptions

- Volcanoes are mountains with openings in Earth's crust through which magma, gases, and ash reach Earth's surface.
- Volcanoes can change Earth's surface.
- When the magma erupts from the volcano the top of the mountain can be changed, either built up or exploded off.
- The lava and ash can destroy forests and bury fields.
- Volcanic eruptions can even change Earth's weather patterns.
- Volcanic eruptions also occur under the oceans; these volcanoes that are built up are called *seamounts*.
- If the seamount rises above the ocean surface it is called a *volcanic island* (for example Hawaii or Japan).

Earthquakes

- Earthquakes are vibrations on Earth's surface caused by sudden movement in Earth, often along a *fault*, a break in Earth's surface.
- Some earthquakes cause little damage and some cause a lot of damage.
- Large earthquakes can cause landslides.
- Earthquakes under the ocean can cause huge waves, called *tsunamis* that destroy land and cause great damage if they come ashore.

Floods

- Floods occur when a large amount of water covers land that is usually dry.
- When the flood occurs, rapid erosion can take place and move soil and sediments away.
- When the flood recedes, new sediment is left behind and can build up rich soil deposits.

It is not essential for students to know about the movement of Earth's plates (the theory of plate tectonics), or how volcanoes, mountains, and earthquakes are produced.

Assessment Guidelines:

The objective of this indicator is to *explain* the effects natural processes on the Earth's oceans and land; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the various ways that the ocean and land is affected by the processes of weathering, erosion, deposition, landslides, volcanic eruptions, earthquakes and floods. However, appropriate assessments should also require students to *recall* what each of the processes are; *compare* constructive and destructive processes; *illustrate* with pictures or diagrams the changes that take place with these processes; *classify* the processes as constructive or destructive; or *exemplify* ways that the processes affect the land and oceans.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.2 Illustrate the geologic landforms of the ocean floor (including the continental shelf and slope, the mid-ocean ridge, rift zone, trench, and the ocean basin).
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.6), students illustrated Earth's land features, including volcanoes, mountains, valleys, canyons, caverns, and islands). The concept of the geologic landforms of the ocean floor is new content for this grade. This concept will be further studied in high school Earth Science.

It is essential for students to know that the ocean floor contains geologic structures. These features can be illustrated using words descriptions, pictures, or diagrams. These landforms include:

Continental shelf
- The edges of the continents slope down from the shore into the ocean.
- The part of the continent located under the water is known as the *continental shelf*.
- The width of the continental shelf varies around the edges of the continents.
- In some places the continental shelf is fairly shallow and in other place it becomes very deep, but it is not the deepest part of the ocean.

Continental slope
- The steep slope where the continental shelf drops to the bottom of the ocean floor is called the *continental slope*.
- The depth of the ocean water increases greatly here.

Mid-ocean ridge
- On the bottom of the ocean, there is a central ridge, or mountain range, that divides the ocean floor into two parts.
- These underwater volcanic mountains are known as the *mid-ocean ridge*.
- Volcanic mountains not formed on the mid-ocean ridge are called *seamounts*.

Rift zone
- In the center of the highest part of the mid-ocean ridge is a narrow trench called a *rift*.
- Underwater volcanic activity that adds mountains to either side of the mid-ocean ridge occurs at the *rift zone*.

Trenches
- There are many steep-sided canyons and deep, narrow valleys in the bottom of the ocean.
- Ocean *trenches* are the deepest part of the ocean basin and are deeper than any valley found on land.

Ocean basin
- Located on either side of the mid-ocean ridge is the *ocean basin*.
- It is made up of low hills and flat plains.
- The flat area of the ocean basin is called the *abyssal plain*. Seamounts are generally formed on the ocean basin.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

It is not essential for students to know about ocean floor spreading; continental plates and boundaries; or deep-ocean exploration efforts. Deep ocean-mapping methods are not necessary, but in discussion or activity it may give the students a better idea of how scientists learned about the features on the ocean floor.

Assessment Guidelines:
The objective of this indicator is to *illustrate* geologic landforms of the ocean floor; therefore, the primary focus of assessment should be to give or use illustrations to show aspects of these features (including the continental shelf and slope, the mid-ocean ridge, rift zone, trench, and the ocean basin). However, appropriate assessments should also require students to *recall* information about each landform region of the ocean floor; or *interpret* a diagram showing the ocean floor regions.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.3 Compare continental and oceanic landforms.
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.6), students illustrated Earth's continental landforms, including volcanoes, mountains, valleys, canyons, caverns, and islands. In 5th grade (5-3.2), students illustrated landforms found on the ocean floor. Students should be able to make a comparison between these two types of landforms.

It is essential for students to know that Earth is made of solid land. Some of the land is located above Earth's water and some is located below the oceans. However, there are similarities and differences between the landforms found on the continents and those found on the ocean floor.

NOTE TO TEACHER: Students need to base comparisons of continental and oceanic landforms on content from previous learning and other indicators.

Continental and Oceanic Landforms		
Description	**Continental**	**Oceanic**
Low land between hills or mountains	Valley	Rift
Deep valley with high steep sides	Canyon	Trench
An opening in the surface from which lava flows	Volcano	Seamount and Volcanic islands
Land which rises high above the ground	Mountain range	Mid-ocean ridge
Wide, flat areas of land	Plains	Abyssal plains

It is not essential for students to know a comparison of other features or compare how these features are made.

Assessment Guidelines:
The objective of this indicator is to *compare* continental and oceanic landforms; therefore, the primary focus of assessment should be to detect ways that these objects are alike and different. However, appropriate assessments should also require students to *identify* the landform as continental or oceanic; or *exemplify* the landforms by their locations.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.4 Explain how waves, currents, tides, and storms affect the geologic features of the ocean shore zone (including beaches, barrier islands, estuaries, and inlets).
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 4th grade (4-4.4), students summarized the conditions and effects of severe weather phenomena including thunderstorms and hurricanes. The concept of the geologic features of the ocean shore zone is new content for this grade.

It is essential for students to know that the area where the ocean meets the land is called the *ocean shore zone*. The ocean shore zone has distinct geologic features that can be affected by waves, currents, tides, and storms. Beaches, barrier islands, estuaries, and inlets are all affected by these natural processes.

Beaches

- The *shoreline,* or *coast*, is the area where the land meets the ocean.
- Some shorelines are rocky. Shorelines made of sand are called *beaches*.
- Shorelines are always changing because of wind and water.
- Waves can wear away the land and expose a rocky shore or the waves can deposit sand along the shore and form a beach. If the waves reach the beach at an angle, the sand is moved along the coast.
- Currents, called *longshore currents*, along the shoreline can move sand from one location to another.
- Tides can bring in sand, shells, and ocean sediments at high tide and leave them behind when the tide goes out.
- Storms can cause wave action that removes sand from beaches.

Barrier islands

- Islands are pieces of land surrounded by water on all sides. Islands with sandy beaches are called *barrier islands*.
- These barrier islands are naturally occurring and function to protect the mainland from the effects of waves on its shore.
- As the waves deposit sand on the beaches, the shapes of the barrier islands change.
- Currents can move the sand from one end of the island to the other.

Estuaries

- All rivers flow into the oceans.
- The area where a river meets the ocean is known as an *estuary*.
- Estuaries have a mixture of freshwater and saltwater.
- Waves can deposit sand in the estuaries.
- At high tide, ocean water brings in sediments and sea life that feed and nourish life in the estuary.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

Inlets

- *Inlets* are the water-filled spaces between the barrier islands.
- As the tides change, the amount of water in the inlet will change.
- Ocean currents and storms can change the shape of an inlet opening.

Large storms, for example hurricanes, can also cause massive construction or destruction of beaches, barrier islands, estuaries, and inlets because they produce high waves, storm surges, and heavy winds.

NOTE TO TEACHER: Looking at a map of South Carolina with its many beaches, barrier islands, estuaries, and inlets will allow students to visualize these features for better understanding. Pictures of these features on the South Carolina coast would also be helpful.

It is not essential for students to know about harbors or sounds as features. The effects of rip currents are not necessary; longshore currents are the primary current studied in this indicator.

Assessment Guidelines:

The objective of this indicator is to *explain* the effects waves, currents, tides, and storms on the ocean shore zone; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the various ways that beaches, barrier islands, estuaries, and inlets are affected by these events. However, appropriate assessments should also require students to *recall* that beaches, barrier islands, estuaries, and inlets are geologic features of the ocean shore zone; or *infer* changes on the ocean shore zone that occur as a result of waves, currents, tides and storms.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.5 Compare the movement of water by waves, currents, and tides.
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-5.4), students explained the relationship between the motion of an object and the pull of gravity. In 4th grade, students compared the location of Earth and the Moon in the solar system (4-3.2) and illustrated the Moon's phases and the Moon's effect on ocean tides (4-3.6). In 8th grade (8-4.4), students will explain how the motions of Earth and the Moon affect the motion of the tides.

It is essential for students to know that water on Earth can be moved in various ways. Three ways that water can be moved are by:

Waves
- The repeated movement of water is known as a *wave*.
- All waves have the same parts. The highest part is known as the *crest* and the lowest part is known as the *trough*.
- Most ocean waves are caused by winds that are blown across the surface of the water.
- A wave changes shape when it reaches the shore.
- As the top of the wave curls over it forms a *breaker*.
- Sometimes giant sea waves, called *tsunamis*, are caused by underwater earthquakes, volcanic eruptions, or landslides.

Currents
- Flowing streams of water that move continually through the ocean in a specific direction are called *currents*.
- Some currents flow at the ocean's surface and some are found deeper in the ocean.
- *Surface currents* are caused by the movement of Earth and by the force and direction of wind.
- The movement of Earth and winds causes these currents to flow along curved paths.
- Warm water and cold water are moved to different regions on Earth as a result of currents.
- *Warm surface currents* are driven by Earth's rotation from the tropics to higher latitudes.
- *Cold surface currents* are driven by Earth's rotation from the polar latitudes toward the equator.

Tides
- Several times during the day, the level of water at the ocean shore changes.
- This regular rise and fall of waters in oceans and seas is called a *tide*.
- Tides are caused by the pull of the Moon's *gravity* on Earth.
- As the Moon moves in relation to Earth, the water on Earth moves too.
- As Earth spins on its axis, the part of the ocean facing the Moon will bulge.
- *High tide* occurs when the water level is at its highest point.
- *Low tide* occurs when the water level is at it lowest point.
- Tides rise and fall about twice a day.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

It is not essential for students to know about the formation of deep-ocean currents; or explain how the motions of Earth and the Moon affect the motion of the tides, as this will be discussed further in 8th grade.

Assessment Guidelines:
The objective of this indicator is to *compare* the ways that waves, currents, and tides move water; therefore, the primary focus of assessment should be to detect ways that water is moved by these ocean movements. However, appropriate assessments should also require students to *identify* a wave, current, or tides based on its description; *classify* a wave, current, or tide by their characteristics; *identify* parts of a wave; *compare* high and low tides; or *compare* warm and cold surface currents.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.6 Explain how human activity (including conservation efforts and pollution) has affected the land and the oceans of Earth.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 4th grade (4-2.6), students explained how organisms cause changes in their environment. In 7th grade (7-4.6), students will explain the implications of the depletion of resources and the importance of conservation of resources.

It is essential for students to know that human activities can benefit the land and oceans by preserving the resources that these areas provide.

- *Natural resources* are the materials that people can take or use from Earth.
- Resources may include air, water, trees, rocks and minerals, soil, or coal and oil.

Conservation Efforts

- The wise use of natural resources is called *conservation*.
- Human activities that help to keep the natural resources of Earth available and clear of pollution are conservation efforts.
- Some efforts involve everyone trying to *reduce* (use less of something), *reuse* (use something over again), and *recycle* (make something new from an old product).
- Other efforts involve trying to save the land and oceans through clean-up projects, installing fence lines to prevent dune erosion or jetties along the entrance to harbors or groins along beaches in an effort to keep sand from washing away.
- Beach renourishment projects help to restore sand on beaches.
- Planting trees, bushes, or grass is a way to improve air quality as well as keep erosion from carrying away soil.

Pollution

- *Pollution* is anything that harms the natural environment.
- When the taking or using of natural resources causes harm to Earth's air, water including oceans, or land, then the human activity has caused pollution.
- Oceans are rich in food, minerals, and other resources and can be easily polluted.
- Human activities can also harm the land and oceans causing resources to be polluted or destroyed.
- Sometimes people may allow materials to be dumped into rivers not thinking that rivers flow into the estuaries and ocean where they are harmful to life there.
- Careless dumping of trash on land or in oceans pollutes those areas; smoke and fumes from burning fuels pollutes the air; oil spills harm the ocean and can cause life there to be killed.
- Careless human activities in agriculture, industry, construction, or mining can cause pollution on the land, in the water, and in the air.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

Assessment Guidelines:

The objective of this indicator is to *explain* the effects of human activity on the land and oceans of Earth; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how the various efforts or activities by people have conserved resulted in harm or pollution to these areas. However, appropriate assessments should also require students to *summarize* conservation efforts that make wise use of the land and oceans; *summarize* activities that pollute the land or oceans; *identify* areas of the land or ocean where resources are being conserved; or *exemplify* ways that the human activities affect land and oceans.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.1 Explain how natural processes (including weathering, erosion, deposition, landslides, volcanic eruptions, earthquakes, and floods) affect Earth's oceans and land in constructive and destructive ways.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.8), students illustrated changes in Earth's surface that are due to slow processes (including weathering, erosion, and deposition) and those changes due to rapid features (landslides, volcanic eruptions, floods and earthquakes). The primary focus was to provide examples of such changes. In 8th grade (8-3.6) the concept of plate tectonics, the movement of Earth's crustal plates, including its relationship to earthquakes and volcanoes, will be further studied.

It is essential for students to know Earth's oceans and land can be affected in constructive ways and destructive ways by natural processes.

Constructive
- Processes that create landforms (deposition, landslides, volcanic eruptions, floods)

Destructive
- Processes that destroy landforms (weathering, erosion, landslides, volcanic eruptions, earthquakes, floods)

Natural processes that can affect Earth's oceans and land include:

Weathering
- Weathering is a general term used to describe processes that break down rocks at or near the surface of the earth.
- Weathering can be either physical or chemical.
- These processes cause the surface of the earth to dissolve, decompose, and break into smaller pieces.
- Water is an important cause of weathering.
- Plants cause weathering when roots break apart rock.
- Changes in temperature can break rock, as well as ice forming inside cracks in the rock causing it to break even more.
- Anything that causes rocks to wear down or break apart is a cause of weathering.

Erosion
- Erosion is the movement of *sediments* and soil by wind, water, ice, and gravity.

Deposition
- Deposition is the dropping, or *depositing*, of sediments by water, wind, or ice.
- Deposition builds up new land on Earth's surface, like a delta at the end of a river or the pile up of a sand dune in the desert.
- Shells on the beach are deposition by ocean waves.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

Landslides

- Landslides are mass movements of land due to gravity.
- Landslides can cause buildings to fall, or power and gas lines to break.
- Landslides even occur on the continental slope in the ocean.

Volcanic eruptions

- Volcanoes are mountains with openings in Earth's crust through which magma, gases, and ash reach Earth's surface.
- Volcanoes can change Earth's surface.
- When the magma erupts from the volcano the top of the mountain can be changed, either built up or exploded off.
- The lava and ash can destroy forests and bury fields.
- Volcanic eruptions can even change Earth's weather patterns.
- Volcanic eruptions also occur under the oceans; these volcanoes that are built up are called *seamounts*.
- If the seamount rises above the ocean surface it is called a *volcanic island* (for example Hawaii or Japan).

Earthquakes

- Earthquakes are vibrations on Earth's surface caused by sudden movement in Earth, often along a *fault*, a break in Earth's surface.
- Some earthquakes cause little damage and some cause a lot of damage.
- Large earthquakes can cause landslides.
- Earthquakes under the ocean can cause huge waves, called *tsunamis* that destroy land and cause great damage if they come ashore.

Floods

- Floods occur when a large amount of water covers land that is usually dry.
- When the flood occurs, rapid erosion can take place and move soil and sediments away.
- When the flood recedes, new sediment is left behind and can build up rich soil deposits.

It is not essential for students to know about the movement of Earth's plates (the theory of plate tectonics), or how volcanoes, mountains, and earthquakes are produced.

Assessment Guidelines:

The objective of this indicator is to *explain* the effects natural processes on the Earth's oceans and land; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the various ways that the ocean and land is affected by the processes of weathering, erosion, deposition, landslides, volcanic eruptions, earthquakes and floods. However, appropriate assessments should also require students to *recall* what each of the processes are; *compare* constructive and destructive processes; *illustrate* with pictures or diagrams the changes that take place with these processes; *classify* the processes as constructive or destructive; or *exemplify* ways that the processes affect the land and oceans.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.2 Illustrate the geologic landforms of the ocean floor (including the continental shelf and slope, the mid-ocean ridge, rift zone, trench, and the ocean basin).
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.6), students illustrated Earth's land features, including volcanoes, mountains, valleys, canyons, caverns, and islands). The concept of the geologic landforms of the ocean floor is new content for this grade. This concept will be further studied in high school Earth Science.

It is essential for students to know that the ocean floor contains geologic structures. These features can be illustrated using words descriptions, pictures, or diagrams. These landforms include:

Continental shelf
- The edges of the continents slope down from the shore into the ocean.
- The part of the continent located under the water is known as the *continental shelf*.
- The width of the continental shelf varies around the edges of the continents.
- In some places the continental shelf is fairly shallow and in other place it becomes very deep, but it is not the deepest part of the ocean.

Continental slope
- The steep slope where the continental shelf drops to the bottom of the ocean floor is called the *continental slope*.
- The depth of the ocean water increases greatly here.

Mid-ocean ridge
- On the bottom of the ocean, there is a central ridge, or mountain range, that divides the ocean floor into two parts.
- These underwater volcanic mountains are known as the *mid-ocean ridge*.
- Volcanic mountains not formed on the mid-ocean ridge are called *seamounts*.

Rift zone
- In the center of the highest part of the mid-ocean ridge is a narrow trench called a *rift*.
- Underwater volcanic activity that adds mountains to either side of the mid-ocean ridge occurs at the *rift zone*.

Trenches
- There are many steep-sided canyons and deep, narrow valleys in the bottom of the ocean.
- Ocean *trenches* are the deepest part of the ocean basin and are deeper than any valley found on land.

Ocean basin
- Located on either side of the mid-ocean ridge is the *ocean basin*.
- It is made up of low hills and flat plains.
- The flat area of the ocean basin is called the *abyssal plain*. Seamounts are generally formed on the ocean basin.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

It is not essential for students to know about ocean floor spreading; continental plates and boundaries; or deep-ocean exploration efforts. Deep ocean-mapping methods are not necessary, but in discussion or activity it may give the students a better idea of how scientists learned about the features on the ocean floor.

Assessment Guidelines:
The objective of this indicator is to *illustrate* geologic landforms of the ocean floor; therefore, the primary focus of assessment should be to give or use illustrations to show aspects of these features (including the continental shelf and slope, the mid-ocean ridge, rift zone, trench, and the ocean basin). However, appropriate assessments should also require students to *recall* information about each landform region of the ocean floor; or *interpret* a diagram showing the ocean floor regions.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.3 Compare continental and oceanic landforms.
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.6), students illustrated Earth's continental landforms, including volcanoes, mountains, valleys, canyons, caverns, and islands. In 5th grade (5-3.2), students illustrated landforms found on the ocean floor. Students should be able to make a comparison between these two types of landforms.

It is essential for students to know that Earth is made of solid land. Some of the land is located above Earth's water and some is located below the oceans. However, there are similarities and differences between the landforms found on the continents and those found on the ocean floor.

NOTE TO TEACHER: Students need to base comparisons of continental and oceanic landforms on content from previous learning and other indicators.

Continental and Oceanic Landforms		
Description	**Continental**	**Oceanic**
Low land between hills or mountains	Valley	Rift
Deep valley with high steep sides	Canyon	Trench
An opening in the surface from which lava flows	Volcano	Seamount and Volcanic islands
Land which rises high above the ground	Mountain range	Mid-ocean ridge
Wide, flat areas of land	Plains	Abyssal plains

It is not essential for students to know a comparison of other features or compare how these features are made.

Assessment Guidelines:
The objective of this indicator is to *compare* continental and oceanic landforms; therefore, the primary focus of assessment should be to detect ways that these objects are alike and different. However, appropriate assessments should also require students to *identify* the landform as continental or oceanic; or *exemplify* the landforms by their locations.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.4 Explain how waves, currents, tides, and storms affect the geologic features of the ocean shore zone (including beaches, barrier islands, estuaries, and inlets).
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 4th grade (4-4.4), students summarized the conditions and effects of severe weather phenomena including thunderstorms and hurricanes. The concept of the geologic features of the ocean shore zone is new content for this grade.

It is essential for students to know that the area where the ocean meets the land is called the *ocean shore zone*. The ocean shore zone has distinct geologic features that can be affected by waves, currents, tides, and storms. Beaches, barrier islands, estuaries, and inlets are all affected by these natural processes.

Beaches

- The *shoreline,* or *coast*, is the area where the land meets the ocean.
- Some shorelines are rocky. Shorelines made of sand are called *beaches*.
- Shorelines are always changing because of wind and water.
- Waves can wear away the land and expose a rocky shore or the waves can deposit sand along the shore and form a beach. If the waves reach the beach at an angle, the sand is moved along the coast.
- Currents, called *longshore currents*, along the shoreline can move sand from one location to another.
- Tides can bring in sand, shells, and ocean sediments at high tide and leave them behind when the tide goes out.
- Storms can cause wave action that removes sand from beaches.

Barrier islands

- Islands are pieces of land surrounded by water on all sides. Islands with sandy beaches are called *barrier islands*.
- These barrier islands are naturally occurring and function to protect the mainland from the effects of waves on its shore.
- As the waves deposit sand on the beaches, the shapes of the barrier islands change.
- Currents can move the sand from one end of the island to the other.

Estuaries

- All rivers flow into the oceans.
- The area where a river meets the ocean is known as an *estuary*.
- Estuaries have a mixture of freshwater and saltwater.
- Waves can deposit sand in the estuaries.
- At high tide, ocean water brings in sediments and sea life that feed and nourish life in the estuary.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

Inlets

- *Inlets* are the water-filled spaces between the barrier islands.
- As the tides change, the amount of water in the inlet will change.
- Ocean currents and storms can change the shape of an inlet opening.

Large storms, for example hurricanes, can also cause massive construction or destruction of beaches, barrier islands, estuaries, and inlets because they produce high waves, storm surges, and heavy winds.

NOTE TO TEACHER: Looking at a map of South Carolina with its many beaches, barrier islands, estuaries, and inlets will allow students to visualize these features for better understanding. Pictures of these features on the South Carolina coast would also be helpful.

It is not essential for students to know about harbors or sounds as features. The effects of rip currents are not necessary; longshore currents are the primary current studied in this indicator.

Assessment Guidelines:

The objective of this indicator is to *explain* the effects waves, currents, tides, and storms on the ocean shore zone; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the various ways that beaches, barrier islands, estuaries, and inlets are affected by these events. However, appropriate assessments should also require students to *recall* that beaches, barrier islands, estuaries, and inlets are geologic features of the ocean shore zone; or *infer* changes on the ocean shore zone that occur as a result of waves, currents, tides and storms.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.5 Compare the movement of water by waves, currents, and tides.
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-5.4), students explained the relationship between the motion of an object and the pull of gravity. In 4th grade, students compared the location of Earth and the Moon in the solar system (4-3.2) and illustrated the Moon's phases and the Moon's effect on ocean tides (4-3.6). In 8th grade (8-4.4), students will explain how the motions of Earth and the Moon affect the motion of the tides.

It is essential for students to know that water on Earth can be moved in various ways. Three ways that water can be moved are by:

Waves
- The repeated movement of water is known as a *wave*.
- All waves have the same parts. The highest part is known as the *crest* and the lowest part is known as the *trough*.
- Most ocean waves are caused by winds that are blown across the surface of the water.
- A wave changes shape when it reaches the shore.
- As the top of the wave curls over it forms a *breaker*.
- Sometimes giant sea waves, called *tsunamis*, are caused by underwater earthquakes, volcanic eruptions, or landslides.

Currents
- Flowing streams of water that move continually through the ocean in a specific direction are called *currents*.
- Some currents flow at the ocean's surface and some are found deeper in the ocean.
- *Surface currents* are caused by the movement of Earth and by the force and direction of wind.
- The movement of Earth and winds causes these currents to flow along curved paths.
- Warm water and cold water are moved to different regions on Earth as a result of currents.
- *Warm surface currents* are driven by Earth's rotation from the tropics to higher latitudes.
- *Cold surface currents* are driven by Earth's rotation from the polar latitudes toward the equator.

Tides
- Several times during the day, the level of water at the ocean shore changes.
- This regular rise and fall of waters in oceans and seas is called a *tide*.
- Tides are caused by the pull of the Moon's *gravity* on Earth.
- As the Moon moves in relation to Earth, the water on Earth moves too.
- As Earth spins on its axis, the part of the ocean facing the Moon will bulge.
- *High tide* occurs when the water level is at its highest point.
- *Low tide* occurs when the water level is at it lowest point.
- Tides rise and fall about twice a day.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

It is not essential for students to know about the formation of deep-ocean currents; or explain how the motions of Earth and the Moon affect the motion of the tides, as this will be discussed further in 8th grade.

Assessment Guidelines:
The objective of this indicator is to *compare* the ways that waves, currents, and tides move water; therefore, the primary focus of assessment should be to detect ways that water is moved by these ocean movements. However, appropriate assessments should also require students to *identify* a wave, current, or tides based on its description; *classify* a wave, current, or tide by their characteristics; *identify* parts of a wave; *compare* high and low tides; or *compare* warm and cold surface currents.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

5-3.6 Explain how human activity (including conservation efforts and pollution) has affected the land and the oceans of Earth.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 4th grade (4-2.6), students explained how organisms cause changes in their environment. In 7th grade (7-4.6), students will explain the implications of the depletion of resources and the importance of conservation of resources.

It is essential for students to know that human activities can benefit the land and oceans by preserving the resources that these areas provide.

- *Natural resources* are the materials that people can take or use from Earth.
- Resources may include air, water, trees, rocks and minerals, soil, or coal and oil.

Conservation Efforts

- The wise use of natural resources is called *conservation*.
- Human activities that help to keep the natural resources of Earth available and clear of pollution are conservation efforts.
- Some efforts involve everyone trying to *reduce* (use less of something), *reuse* (use something over again), and *recycle* (make something new from an old product).
- Other efforts involve trying to save the land and oceans through clean-up projects, installing fence lines to prevent dune erosion or jetties along the entrance to harbors or groins along beaches in an effort to keep sand from washing away.
- Beach renourishment projects help to restore sand on beaches.
- Planting trees, bushes, or grass is a way to improve air quality as well as keep erosion from carrying away soil.

Pollution

- *Pollution* is anything that harms the natural environment.
- When the taking or using of natural resources causes harm to Earth's air, water including oceans, or land, then the human activity has caused pollution.
- Oceans are rich in food, minerals, and other resources and can be easily polluted.
- Human activities can also harm the land and oceans causing resources to be polluted or destroyed.
- Sometimes people may allow materials to be dumped into rivers not thinking that rivers flow into the estuaries and ocean where they are harmful to life there.
- Careless dumping of trash on land or in oceans pollutes those areas; smoke and fumes from burning fuels pollutes the air; oil spills harm the ocean and can cause life there to be killed.
- Careless human activities in agriculture, industry, construction, or mining can cause pollution on the land, in the water, and in the air.

Landforms and Oceans

5-3 The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

Assessment Guidelines:

The objective of this indicator is to *explain* the effects of human activity on the land and oceans of Earth; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how the various efforts or activities by people have conserved resulted in harm or pollution to these areas. However, appropriate assessments should also require students to *summarize* conservation efforts that make wise use of the land and oceans; *summarize* activities that pollute the land or oceans; *identify* areas of the land or ocean where resources are being conserved; or *exemplify* ways that the human activities affect land and oceans.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.1 Recall that matter is made up of particles too small to be seen.
Taxonomy level: 1.2-B Remember Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of matter being made up of particles too small to be seen in previous grades. Students will further develop this concept in 7th grade (7-5.1) when they identify these particles as atoms.

It is essential for students to know that matter is anything that has mass and takes up space (has volume) and that all matter is made up of very small particles too small to be seen. Even though these particles are very small, they cause matter to have its basic properties.

It is not essential for students to know the name of these particles; there is no study of atoms at this time.

Assessment Guidelines:
The objective of this indicator is to *recall* that matter is made up of particles too small to be seen; therefore, the primary focus of assessment should be to remember this information from memory. However, appropriate assessments should also require students to *identify* matter as being made up of very small particles; or recall that matter has mass and takes up space.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.2 Compare the physical properties of the states of matter (including volume, shape, and the movement and spacing of particles).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 2nd grade (2-4.1), students recalled the properties of solids and liquids and in 3rd grade (3-4.1) students classified different forms of matter (including solids, liquids, and gases) according to their observable (shape) and measurable (volume) properties. Students have not been introduced in previous grades to the concept of particles of matter and how they are affected by the states of matter. Students will further develop this concept in the 7th grade (7-5.10) as they compare physical to chemical changes.

It is essential for students to know that solids, liquids, and gases can be compared based on their physical properties (including volume, shape, and the movement and spacing of particles):

Solids

- *Solids* have a definite shape and volume.
- Particles in a solid are very close to one another (dense) and vibrate, but stay in the same place.
- The volume of a solid with rectangular sides can be determined by measuring with a ruler and calculating height x width x length.
- The volume of an irregularly shaped solid can be determined by water displacement in a graduated cylinder.
- The volume of water displaced equals the volume of the object.

Liquids

- *Liquids* have a definite volume, but their shape changes according to the shape of their containers.
- The particles are also close to one another, but they are able to move apart from each other and flow from place to place.
- The volume of a liquid can be measured using a graduated cylinder or graduated syringe.

Gases

- *Gases* have no definite shape or volume, but take the shape and volume of their containers, filling the space available.
- The particles easily move far apart from each other and spread out through the available space.

It is because of the movement and spacing of particles of matter that the volume and shape of solids, liquids, and gases differ.

It is not essential for students to know that the volume of a gas changes with pressure changes or how temperature changes can affect volumes of gases, liquids, and solids. Students do not need to know how to measure the volume of a gas.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

Assessment Guidelines:

The objective of this indicator is to *compare* the physical properties of the states of matter; therefore, the primary focus of assessment should be to detect ways the physical properties of solids, liquids, and gases are alike and different, including their volumes, shapes, and movement and spacing of particles. However, appropriate assessments should require students to *interpret* a diagram of particles of matter in solids, liquids, and gases and to *recognize* which diagram of particles is associated with which state of matter based on the movement and spacing of the particles; to *interpret* a diagram of measuring tools to determine the volume of solids or liquids; and to *recognize* which state of matter is described given various physical properties.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.3 Summarize the characteristics of a mixture, recognizing a solution as a kind of mixture.

Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of how different materials can be mixed together and then separated again in 2nd grade (2-4.4). The concept of solutions being a kind of mixture is new to this grade level. In the 7th grade (7-5.2), students will further develop the concept of mixtures by distinguishing them from elements and compounds.

It is essential for students to know the characteristics of mixtures.

- *Mixtures* are composed of two or more substances that are mixed together but can be separated from each other.
- Mixtures can be made from various combinations of solids, liquids, or gases.
- The substances in a mixture do not permanently change in the mixture, but they keep their separate properties.

Solutions are one type of mixture is a solution.

- They are composed of substances that mix so completely that they cannot be distinguished as separate substances.
- They can, however, be separated back into the separate substances.
- One example of a solution is a mixture of a solid that dissolves completely in a liquid, for example salt or sugar in water.

It is not essential for students to know that mixtures can be heterogeneous or homogeneous or that they can be distinguished from elements and compounds.

Assessment Guidelines:

One objective of this indicator is to *summarize* the characteristics of mixtures; therefore, the primary focus of assessment should be to generalize major point about the characteristics of mixtures. However, appropriate assessments should also require students to *recognize* a substance as a mixture based on characteristics; or *identify* substances in a mixture based on their properties.

Another objective is to *recognize* that a solution is a kind of mixture; therefore, the primary focus of that objective is to retrieve from memory the fact that solutions are a type of mixture. However, appropriate assessments should also require students to *classify* various substances as mixtures or solutions based on characteristics.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.4 Use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.
Taxonomy level: 3.2-B Apply Procedural Knowledge

Previous/Future knowledge: In 2nd grade (2-4.4), students recognized that different materials can be mixed together and then separated again. They have been introduced to the concept of magnetic attraction in 2nd grade (2-5.1) and in 4th grade (4-5.9) and to the process of evaporation in 3rd grade (3-4.2). Students will further develop the concept of physical changes in 7th grade (7-5.10)

It is essential for students to know and use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.

Filtration
- *Filtration* is used to separate solid particles from a liquid.
- For example, pouring the mixture through a filter paper in a funnel will trap the solid particles and only allow the particles of the liquid to pass through.
- This method is used in water treatment plants as part of the process for separating dirt and other solid particles from water to produce clean drinking water.

Sifting
- *Sifting* is used to separate smaller solid particles from larger solid particles.
- For example, the mixture of different sized solid particles can be put into a container that has a screen material at the bottom with holes of a certain size.
- When the mixture is shaken, the smaller particles go through the screen leaving the larger particles in the container.
- Cooks, for example, sift flour to get a small particle size for baking leaving larger particles of flour in the sifter above the screen.
- Sand and gravel companies, for example, separate rocks into different sized particles for road building and other construction projects using this method.

Magnetic attraction
- *Magnetic attraction* is used to separating magnetic material from a mixture of other substances.
- When a magnet is stirred through the mixture, it pulls out the magnetic material from the mixture.
- A cow magnet, for example, is given to a cow to swallow. It stays in the first stomach of the cow keeping magnetic materials like wire and other harmful materials that cows swallow from going into the rest of their digestive system.

Evaporation

- *Evaporation is* used to separate a solid that has dissolved in a liquid solution.
- The solution is heated or left uncovered until all the liquid turns to a gas (evaporates) leaving the solid behind.
- Salt in salt water or ocean water, for example, is separated by heating the solution until all the water evaporates leaving the solid salt in the container.

Chromatography

- *Chromatography* is used to separate and analyze the solutes in a solution.
- For example, a small amount (2-3 drops) of the solution is put on a piece of filter paper, which is put in a solvent.
- The substances in the solution that dissolve most easily travel the furthest; and substances that do not dissolve easily do not travel very far.
- The bands of color that are formed allow scientists to identify the substances in the solution by comparing them to the location of known substances forming bands of color on different filter papers.

Floatation

- *Floatation* is used to separate solids that float from the remaining liquid in a mixture.
- The solids are stirred and when they float to the top, they are skimmed off the surface of the liquid and put into a different container.
- This method is used, for example, in some water purification plants.

It is not essential for students to know that these processes depend on physical changes, not chemical changes.

Assessment Guidelines:
The objective of this indicator is to *use* the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures; therefore, the primary focus of assessment should be to apply the procedures to separate a given mixture. However, appropriate assessments should also require students to *recognize* a given procedure that would be appropriate to separate a given mixture; or *summarize* how to separate a given mixture.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.5 Explain how the solute and the solvent in a solution determine the concentration.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of solutions, solvents, solutes, or concentrations in previous grades. Students will further develop the concepts of mixtures and concentrations in 7th grade (7-5.2 and 7-5.6).

It is essential for students to know that solutions are types of mixtures and that they are defined by the particles in them.

- The substance in a solution that is in the greatest amount is the *solvent*. It is usually the liquid.
- The substance in a solution that is in the least amount is the *solute*. It is usually the solid.

The relationship of the amount of solute to solvent determines the *concentration* of a solution.

- The more solute a solution has compared to the amount of solvent, the more concentrated it is said to be.
- When two solutions contain the same amount of solvent, the one with the greater amount of solute is the more concentrated solution
- In order to make a solution more concentrated, more solute is added.
- To make a solution less concentrated, more solvent is added.

It is not essential for students to know specific quantitative relationships (ratios) of solutes and solvents in specific percent concentrations for solutions.

Assessment Guidelines:

The objective of this indicator is to *explain* how the solvent and solute in a solution determine the concentration; therefore, the primary focus of assessment should be to construct a cause-and-effect model for how the relationship of solvent to solute in a solution determines the concentration. However, appropriate assessments should also require students to *recognize* the solute and solvent in a solution; or to *summarize* how the relationship of solute to solvent can determine the concentration of a solution.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.6 Explain how temperature change, particle size, and stirring affect the rate of dissolving.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-4.2), students explained how water and other substances changed from one state to another by adding or removing heat. Students have not been introduced to the concepts of rate of dissolving of solutes in solutions in previous grades. They will further develop these concepts of rate of dissolving in high school Physical Science (PS-3.1).

It is essential for students to know that solutes (solids) dissolve in solvents (liquids) in solutions in different amounts in given times, which is called the *rate of dissolving*. The rate of dissolving can be affected by several factors.

Temperature change
- Usually, if the temperature increases, more of the solute will dissolve faster.

Particle size
- Usually, if the particle sizes are smaller, more of the solute will dissolve faster.

Stirring
- Usually, if the solution is stirred, more of the solute will dissolve faster.

It is not essential for students to know about solubility of solutes or whether a solution is saturated or unsaturated.

Assessment Guidelines:
The objective of this indicator is to *explain* how temperature change, particle size, and stirring affect the rate of dissolving; therefore, the primary focus of assessment should be to construct a cause-and-effect model about how these various factors affect the rate of dissolving. However, appropriate assessments should also require students to *recognize* factors that can increase the rate of dissolving and those that can decrease the rate of dissolving; *infer* how a given factor will affect the rate of dissolving; or *summarize* ways that the dissolving of a solute can be increased.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.7 Illustrate the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated.
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of substances chemically combining in previous grades. In 7th grade, students will further develop this concept of chemical changes and reactions (7-5.9 and 7-5.10).

It is essential for students to know that under certain conditions, substances can chemically combine when they are mixed, and the new substance formed cannot easily be separated into the original components. When substances chemically combine, a new substance is formed that has different properties from the original substances that were mixed to form it.

Some examples in which new substances are formed might include:

- To make a cake, you can mix flour, water, egg, oil, and sugar, but after baking in the oven, the cake has different properties.
- Adding vinegar to baking soda will produce a gas. If the liquid is evaporated, a salt will remain.
- When steel wool is exposed to water, rust is formed.

It is not essential for students to know the conditions for a chemical change or reaction to occur.

Assessment Guidelines:
The objective of this indicator is to *illustrate* the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated; therefore, the primary focus of assessment should be to give or use illustrations such as pictures, diagrams, or word descriptions showing that a chemical change has occurred when substances were mixed together. However, appropriate assessments should also require students to *identify* substances that are chemically combined from a mixture because they cannot easily be separated; or *recognize* chemically combined mixtures as new substances that cannot easily be separated.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.8 Explain how the mixing and dissolving of foreign substances is related to the pollution of the water, air, and soil.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.1), students were introduced to the concept of sediment when they classified rocks and soils. They were also introduced to Earth's water features (3-3.5). In 4th grade (4-2.6), students explained how organisms cause changes in their environments (for example, humans polluting the air and dumping toxins into waterways). In 7th grade (7-4.6), students will explain the importance of conservation of resources (including water, air, and soil).

It is essential for students to know that foreign substances can mix with and dissolve in water, air, and soil resulting in pollution.

- These foreign substances are often produced as a result of activities associated with industry, agriculture, burning fossil fuels, or other processes associated with human activities.
- The greater the amount of the foreign substance, the more concentrated or harmful the pollution can be.

It is not essential for students to know exactly what kinds of foreign substances are responsible for pollution of water, air, and soil. Students do not need to know about point and nonpoint sources of pollution.

Assessment Guidelines:
The objective of this indicator is to *explain* how the mixing and dissolving of foreign substances is related to the pollution of water, air, and soil; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how foreign substances cause pollution of water, air, or soil pollution when mixed or dissolved in them. However, appropriate assessments should also require students to *recognize* pollution of water, air, and soil as being formed from foreign substances mixed or dissolved in them; or *summarize* the relationship between water, air, and soil pollutions and the mixing and dissolving of foreign substances.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.1 Recall that matter is made up of particles too small to be seen.
Taxonomy level: 1.2-B Remember Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of matter being made up of particles too small to be seen in previous grades. Students will further develop this concept in 7th grade (7-5.1) when they identify these particles as atoms.

It is essential for students to know that matter is anything that has mass and takes up space (has volume) and that all matter is made up of very small particles too small to be seen. Even though these particles are very small, they cause matter to have its basic properties.

It is not essential for students to know the name of these particles; there is no study of atoms at this time.

Assessment Guidelines:
The objective of this indicator is to *recall* that matter is made up of particles too small to be seen; therefore, the primary focus of assessment should be to remember this information from memory. However, appropriate assessments should also require students to *identify* matter as being made up of very small particles; or recall that matter has mass and takes up space.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.2 Compare the physical properties of the states of matter (including volume, shape, and the movement and spacing of particles).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 2nd grade (2-4.1), students recalled the properties of solids and liquids and in 3rd grade (3-4.1) students classified different forms of matter (including solids, liquids, and gases) according to their observable (shape) and measurable (volume) properties. Students have not been introduced in previous grades to the concept of particles of matter and how they are affected by the states of matter. Students will further develop this concept in the 7th grade (7-5.10) as they compare physical to chemical changes.

It is essential for students to know that solids, liquids, and gases can be compared based on their physical properties (including volume, shape, and the movement and spacing of particles):

Solids

- *Solids* have a definite shape and volume.
- Particles in a solid are very close to one another (dense) and vibrate, but stay in the same place.
- The volume of a solid with rectangular sides can be determined by measuring with a ruler and calculating height x width x length.
- The volume of an irregularly shaped solid can be determined by water displacement in a graduated cylinder.
- The volume of water displaced equals the volume of the object.

Liquids

- *Liquids* have a definite volume, but their shape changes according to the shape of their containers.
- The particles are also close to one another, but they are able to move apart from each other and flow from place to place.
- The volume of a liquid can be measured using a graduated cylinder or graduated syringe.

Gases

- *Gases* have no definite shape or volume, but take the shape and volume of their containers, filling the space available.
- The particles easily move far apart from each other and spread out through the available space.

It is because of the movement and spacing of particles of matter that the volume and shape of solids, liquids, and gases differ.

It is not essential for students to know that the volume of a gas changes with pressure changes or how temperature changes can affect volumes of gases, liquids, and solids. Students do not need to know how to measure the volume of a gas.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

Assessment Guidelines:

The objective of this indicator is to *compare* the physical properties of the states of matter; therefore, the primary focus of assessment should be to detect ways the physical properties of solids, liquids, and gases are alike and different, including their volumes, shapes, and movement and spacing of particles. However, appropriate assessments should require students to *interpret* a diagram of particles of matter in solids, liquids, and gases and to *recognize* which diagram of particles is associated with which state of matter based on the movement and spacing of the particles; to *interpret* a diagram of measuring tools to determine the volume of solids or liquids; and to *recognize* which state of matter is described given various physical properties.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.3 Summarize the characteristics of a mixture, recognizing a solution as a kind of mixture.

Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of how different materials can be mixed together and then separated again in 2nd grade (2-4.4). The concept of solutions being a kind of mixture is new to this grade level. In the 7th grade (7-5.2), students will further develop the concept of mixtures by distinguishing them from elements and compounds.

It is essential for students to know the characteristics of mixtures.

- *Mixtures* are composed of two or more substances that are mixed together but can be separated from each other.
- Mixtures can be made from various combinations of solids, liquids, or gases.
- The substances in a mixture do not permanently change in the mixture, but they keep their separate properties.

Solutions are one type of mixture is a solution.

- They are composed of substances that mix so completely that they cannot be distinguished as separate substances.
- They can, however, be separated back into the separate substances.
- One example of a solution is a mixture of a solid that dissolves completely in a liquid, for example salt or sugar in water.

It is not essential for students to know that mixtures can be heterogeneous or homogeneous or that they can be distinguished from elements and compounds.

Assessment Guidelines:

One objective of this indicator is to *summarize* the characteristics of mixtures; therefore, the primary focus of assessment should be to generalize major point about the characteristics of mixtures. However, appropriate assessments should also require students to *recognize* a substance as a mixture based on characteristics; or *identify* substances in a mixture based on their properties.

Another objective is to *recognize* that a solution is a kind of mixture; therefore, the primary focus of that objective is to retrieve from memory the fact that solutions are a type of mixture. However, appropriate assessments should also require students to *classify* various substances as mixtures or solutions based on characteristics.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.4 Use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.
Taxonomy level: 3.2-B Apply Procedural Knowledge

Previous/Future knowledge: In 2nd grade (2-4.4), students recognized that different materials can be mixed together and then separated again. They have been introduced to the concept of magnetic attraction in 2nd grade (2-5.1) and in 4th grade (4-5.9) and to the process of evaporation in 3rd grade (3-4.2). Students will further develop the concept of physical changes in 7th grade (7-5.10)

It is essential for students to know and use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.

Filtration
- *Filtration* is used to separate solid particles from a liquid.
- For example, pouring the mixture through a filter paper in a funnel will trap the solid particles and only allow the particles of the liquid to pass through.
- This method is used in water treatment plants as part of the process for separating dirt and other solid particles from water to produce clean drinking water.

Sifting
- *Sifting* is used to separate smaller solid particles from larger solid particles.
- For example, the mixture of different sized solid particles can be put into a container that has a screen material at the bottom with holes of a certain size.
- When the mixture is shaken, the smaller particles go through the screen leaving the larger particles in the container.
- Cooks, for example, sift flour to get a small particle size for baking leaving larger particles of flour in the sifter above the screen.
- Sand and gravel companies, for example, separate rocks into different sized particles for road building and other construction projects using this method.

Magnetic attraction
- *Magnetic attraction* is used to separating magnetic material from a mixture of other substances.
- When a magnet is stirred through the mixture, it pulls out the magnetic material from the mixture.
- A cow magnet, for example, is given to a cow to swallow. It stays in the first stomach of the cow keeping magnetic materials like wire and other harmful materials that cows swallow from going into the rest of their digestive system.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

Evaporation

- *Evaporation is* used to separate a solid that has dissolved in a liquid solution.
- The solution is heated or left uncovered until all the liquid turns to a gas (evaporates) leaving the solid behind.
- Salt in salt water or ocean water, for example, is separated by heating the solution until all the water evaporates leaving the solid salt in the container.

Chromatography

- *Chromatography* is used to separate and analyze the solutes in a solution.
- For example, a small amount (2-3 drops) of the solution is put on a piece of filter paper, which is put in a solvent.
- The substances in the solution that dissolve most easily travel the furthest; and substances that do not dissolve easily do not travel very far.
- The bands of color that are formed allow scientists to identify the substances in the solution by comparing them to the location of known substances forming bands of color on different filter papers.

Floatation

- *Floatation* is used to separate solids that float from the remaining liquid in a mixture.
- The solids are stirred and when they float to the top, they are skimmed off the surface of the liquid and put into a different container.
- This method is used, for example, in some water purification plants.

It is not essential for students to know that these processes depend on physical changes, not chemical changes.

Assessment Guidelines:
The objective of this indicator is to *use* the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures; therefore, the primary focus of assessment should be to apply the procedures to separate a given mixture. However, appropriate assessments should also require students to *recognize* a given procedure that would be appropriate to separate a given mixture; or *summarize* how to separate a given mixture.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.1 Recall that matter is made up of particles too small to be seen.
Taxonomy level: 1.2-B Remember Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of matter being made up of particles too small to be seen in previous grades. Students will further develop this concept in 7th grade (7-5.1) when they identify these particles as atoms.

It is essential for students to know that matter is anything that has mass and takes up space (has volume) and that all matter is made up of very small particles too small to be seen. Even though these particles are very small, they cause matter to have its basic properties.

It is not essential for students to know the name of these particles; there is no study of atoms at this time.

Assessment Guidelines:
The objective of this indicator is to *recall* that matter is made up of particles too small to be seen; therefore, the primary focus of assessment should be to remember this information from memory. However, appropriate assessments should also require students to *identify* matter as being made up of very small particles; or recall that matter has mass and takes up space.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.2 Compare the physical properties of the states of matter (including volume, shape, and the movement and spacing of particles).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 2nd grade (2-4.1), students recalled the properties of solids and liquids and in 3rd grade (3-4.1) students classified different forms of matter (including solids, liquids, and gases) according to their observable (shape) and measurable (volume) properties. Students have not been introduced in previous grades to the concept of particles of matter and how they are affected by the states of matter. Students will further develop this concept in the 7th grade (7-5.10) as they compare physical to chemical changes.

It is essential for students to know that solids, liquids, and gases can be compared based on their physical properties (including volume, shape, and the movement and spacing of particles):

Solids

- *Solids* have a definite shape and volume.
- Particles in a solid are very close to one another (dense) and vibrate, but stay in the same place.
- The volume of a solid with rectangular sides can be determined by measuring with a ruler and calculating height x width x length.
- The volume of an irregularly shaped solid can be determined by water displacement in a graduated cylinder.
- The volume of water displaced equals the volume of the object.

Liquids

- *Liquids* have a definite volume, but their shape changes according to the shape of their containers.
- The particles are also close to one another, but they are able to move apart from each other and flow from place to place.
- The volume of a liquid can be measured using a graduated cylinder or graduated syringe.

Gases

- *Gases* have no definite shape or volume, but take the shape and volume of their containers, filling the space available.
- The particles easily move far apart from each other and spread out through the available space.

It is because of the movement and spacing of particles of matter that the volume and shape of solids, liquids, and gases differ.

It is not essential for students to know that the volume of a gas changes with pressure changes or how temperature changes can affect volumes of gases, liquids, and solids. Students do not need to know how to measure the volume of a gas.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

Assessment Guidelines:

The objective of this indicator is to *compare* the physical properties of the states of matter; therefore, the primary focus of assessment should be to detect ways the physical properties of solids, liquids, and gases are alike and different, including their volumes, shapes, and movement and spacing of particles. However, appropriate assessments should require students to *interpret* a diagram of particles of matter in solids, liquids, and gases and to *recognize* which diagram of particles is associated with which state of matter based on the movement and spacing of the particles; to *interpret* a diagram of measuring tools to determine the volume of solids or liquids; and to *recognize* which state of matter is described given various physical properties.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.3 Summarize the characteristics of a mixture, recognizing a solution as a kind of mixture.

Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of how different materials can be mixed together and then separated again in 2nd grade (2-4.4). The concept of solutions being a kind of mixture is new to this grade level. In the 7th grade (7-5.2), students will further develop the concept of mixtures by distinguishing them from elements and compounds.

It is essential for students to know the characteristics of mixtures.

- *Mixtures* are composed of two or more substances that are mixed together but can be separated from each other.
- Mixtures can be made from various combinations of solids, liquids, or gases.
- The substances in a mixture do not permanently change in the mixture, but they keep their separate properties.

Solutions are one type of mixture is a solution.

- They are composed of substances that mix so completely that they cannot be distinguished as separate substances.
- They can, however, be separated back into the separate substances.
- One example of a solution is a mixture of a solid that dissolves completely in a liquid, for example salt or sugar in water.

It is not essential for students to know that mixtures can be heterogeneous or homogeneous or that they can be distinguished from elements and compounds.

Assessment Guidelines:

One objective of this indicator is to *summarize* the characteristics of mixtures; therefore, the primary focus of assessment should be to generalize major point about the characteristics of mixtures. However, appropriate assessments should also require students to *recognize* a substance as a mixture based on characteristics; or *identify* substances in a mixture based on their properties.

Another objective is to *recognize* that a solution is a kind of mixture; therefore, the primary focus of that objective is to retrieve from memory the fact that solutions are a type of mixture. However, appropriate assessments should also require students to *classify* various substances as mixtures or solutions based on characteristics.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.4 Use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.
Taxonomy level: 3.2-B Apply Procedural Knowledge

Previous/Future knowledge: In 2nd grade (2-4.4), students recognized that different materials can be mixed together and then separated again. They have been introduced to the concept of magnetic attraction in 2nd grade (2-5.1) and in 4th grade (4-5.9) and to the process of evaporation in 3rd grade (3-4.2). Students will further develop the concept of physical changes in 7th grade (7-5.10)

It is essential for students to know and use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.

Filtration
- *Filtration* is used to separate solid particles from a liquid.
- For example, pouring the mixture through a filter paper in a funnel will trap the solid particles and only allow the particles of the liquid to pass through.
- This method is used in water treatment plants as part of the process for separating dirt and other solid particles from water to produce clean drinking water.

Sifting
- *Sifting* is used to separate smaller solid particles from larger solid particles.
- For example, the mixture of different sized solid particles can be put into a container that has a screen material at the bottom with holes of a certain size.
- When the mixture is shaken, the smaller particles go through the screen leaving the larger particles in the container.
- Cooks, for example, sift flour to get a small particle size for baking leaving larger particles of flour in the sifter above the screen.
- Sand and gravel companies, for example, separate rocks into different sized particles for road building and other construction projects using this method.

Magnetic attraction
- *Magnetic attraction* is used to separating magnetic material from a mixture of other substances.
- When a magnet is stirred through the mixture, it pulls out the magnetic material from the mixture.
- A cow magnet, for example, is given to a cow to swallow. It stays in the first stomach of the cow keeping magnetic materials like wire and other harmful materials that cows swallow from going into the rest of their digestive system.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

Evaporation

- *Evaporation is* used to separate a solid that has dissolved in a liquid solution.
- The solution is heated or left uncovered until all the liquid turns to a gas (evaporates) leaving the solid behind.
- Salt in salt water or ocean water, for example, is separated by heating the solution until all the water evaporates leaving the solid salt in the container.

Chromatography

- *Chromatography* is used to separate and analyze the solutes in a solution.
- For example, a small amount (2-3 drops) of the solution is put on a piece of filter paper, which is put in a solvent.
- The substances in the solution that dissolve most easily travel the furthest; and substances that do not dissolve easily do not travel very far.
- The bands of color that are formed allow scientists to identify the substances in the solution by comparing them to the location of known substances forming bands of color on different filter papers.

Floatation

- *Floatation* is used to separate solids that float from the remaining liquid in a mixture.
- The solids are stirred and when they float to the top, they are skimmed off the surface of the liquid and put into a different container.
- This method is used, for example, in some water purification plants.

It is not essential for students to know that these processes depend on physical changes, not chemical changes.

Assessment Guidelines:
The objective of this indicator is to *use* the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures; therefore, the primary focus of assessment should be to apply the procedures to separate a given mixture. However, appropriate assessments should also require students to *recognize* a given procedure that would be appropriate to separate a given mixture; or *summarize* how to separate a given mixture.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.5 Explain how the solute and the solvent in a solution determine the concentration.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of solutions, solvents, solutes, or concentrations in previous grades. Students will further develop the concepts of mixtures and concentrations in 7th grade (7-5.2 and 7-5.6).

It is essential for students to know that solutions are types of mixtures and that they are defined by the particles in them.

- The substance in a solution that is in the greatest amount is the *solvent*. It is usually the liquid.
- The substance in a solution that is in the least amount is the *solute*. It is usually the solid.

The relationship of the amount of solute to solvent determines the *concentration* of a solution.

- The more solute a solution has compared to the amount of solvent, the more concentrated it is said to be.
- When two solutions contain the same amount of solvent, the one with the greater amount of solute is the more concentrated solution
- In order to make a solution more concentrated, more solute is added.
- To make a solution less concentrated, more solvent is added.

It is not essential for students to know specific quantitative relationships (ratios) of solutes and solvents in specific percent concentrations for solutions.

Assessment Guidelines:

The objective of this indicator is to *explain* how the solvent and solute in a solution determine the concentration; therefore, the primary focus of assessment should be to construct a cause-and-effect model for how the relationship of solvent to solute in a solution determines the concentration. However, appropriate assessments should also require students to *recognize* the solute and solvent in a solution; or to *summarize* how the relationship of solute to solvent can determine the concentration of a solution.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.6 Explain how temperature change, particle size, and stirring affect the rate of dissolving.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-4.2), students explained how water and other substances changed from one state to another by adding or removing heat. Students have not been introduced to the concepts of rate of dissolving of solutes in solutions in previous grades. They will further develop these concepts of rate of dissolving in high school Physical Science (PS-3.1).

It is essential for students to know that solutes (solids) dissolve in solvents (liquids) in solutions in different amounts in given times, which is called the *rate of dissolving*. The rate of dissolving can be affected by several factors.

Temperature change

- Usually, if the temperature increases, more of the solute will dissolve faster.

Particle size

- Usually, if the particle sizes are smaller, more of the solute will dissolve faster.

Stirring

- Usually, if the solution is stirred, more of the solute will dissolve faster.

It is not essential for students to know about solubility of solutes or whether a solution is saturated or unsaturated.

Assessment Guidelines:

The objective of this indicator is to *explain* how temperature change, particle size, and stirring affect the rate of dissolving; therefore, the primary focus of assessment should be to construct a cause-and-effect model about how these various factors affect the rate of dissolving. However, appropriate assessments should also require students to *recognize* factors that can increase the rate of dissolving and those that can decrease the rate of dissolving; *infer* how a given factor will affect the rate of dissolving; or *summarize* ways that the dissolving of a solute can be increased.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.7 Illustrate the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated.
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of substances chemically combining in previous grades. In 7th grade, students will further develop this concept of chemical changes and reactions (7-5.9 and 7-5.10).

It is essential for students to know that under certain conditions, substances can chemically combine when they are mixed, and the new substance formed cannot easily be separated into the original components. When substances chemically combine, a new substance is formed that has different properties from the original substances that were mixed to form it.

Some examples in which new substances are formed might include:

- To make a cake, you can mix flour, water, egg, oil, and sugar, but after baking in the oven, the cake has different properties.
- Adding vinegar to baking soda will produce a gas. If the liquid is evaporated, a salt will remain.
- When steel wool is exposed to water, rust is formed.

It is not essential for students to know the conditions for a chemical change or reaction to occur.

Assessment Guidelines:
The objective of this indicator is to *illustrate* the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated; therefore, the primary focus of assessment should be to give or use illustrations such as pictures, diagrams, or word descriptions showing that a chemical change has occurred when substances were mixed together. However, appropriate assessments should also require students to *identify* substances that are chemically combined from a mixture because they cannot easily be separated; or *recognize* chemically combined mixtures as new substances that cannot easily be separated.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.8 Explain how the mixing and dissolving of foreign substances is related to the pollution of the water, air, and soil.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.1), students were introduced to the concept of sediment when they classified rocks and soils. They were also introduced to Earth's water features (3-3.5). In 4th grade (4-2.6), students explained how organisms cause changes in their environments (for example, humans polluting the air and dumping toxins into waterways). In 7th grade (7-4.6), students will explain the importance of conservation of resources (including water, air, and soil).

It is essential for students to know that foreign substances can mix with and dissolve in water, air, and soil resulting in pollution.

- These foreign substances are often produced as a result of activities associated with industry, agriculture, burning fossil fuels, or other processes associated with human activities.
- The greater the amount of the foreign substance, the more concentrated or harmful the pollution can be.

It is not essential for students to know exactly what kinds of foreign substances are responsible for pollution of water, air, and soil. Students do not need to know about point and nonpoint sources of pollution.

Assessment Guidelines:
The objective of this indicator is to *explain* how the mixing and dissolving of foreign substances is related to the pollution of water, air, and soil; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how foreign substances cause pollution of water, air, or soil pollution when mixed or dissolved in them. However, appropriate assessments should also require students to *recognize* pollution of water, air, and soil as being formed from foreign substances mixed or dissolved in them; or *summarize* the relationship between water, air, and soil pollutions and the mixing and dissolving of foreign substances.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.6 Explain how temperature change, particle size, and stirring affect the rate of dissolving.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-4.2), students explained how water and other substances changed from one state to another by adding or removing heat. Students have not been introduced to the concepts of rate of dissolving of solutes in solutions in previous grades. They will further develop these concepts of rate of dissolving in high school Physical Science (PS-3.1).

It is essential for students to know that solutes (solids) dissolve in solvents (liquids) in solutions in different amounts in given times, which is called the *rate of dissolving*. The rate of dissolving can be affected by several factors.

Temperature change

- Usually, if the temperature increases, more of the solute will dissolve faster.

Particle size

- Usually, if the particle sizes are smaller, more of the solute will dissolve faster.

Stirring

- Usually, if the solution is stirred, more of the solute will dissolve faster.

It is not essential for students to know about solubility of solutes or whether a solution is saturated or unsaturated.

Assessment Guidelines:
The objective of this indicator is to *explain* how temperature change, particle size, and stirring affect the rate of dissolving; therefore, the primary focus of assessment should be to construct a cause-and-effect model about how these various factors affect the rate of dissolving. However, appropriate assessments should also require students to *recognize* factors that can increase the rate of dissolving and those that can decrease the rate of dissolving; *infer* how a given factor will affect the rate of dissolving; or *summarize* ways that the dissolving of a solute can be increased.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.7 Illustrate the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated.
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of substances chemically combining in previous grades. In 7th grade, students will further develop this concept of chemical changes and reactions (7-5.9 and 7-5.10).

It is essential for students to know that under certain conditions, substances can chemically combine when they are mixed, and the new substance formed cannot easily be separated into the original components. When substances chemically combine, a new substance is formed that has different properties from the original substances that were mixed to form it.

Some examples in which new substances are formed might include:

- To make a cake, you can mix flour, water, egg, oil, and sugar, but after baking in the oven, the cake has different properties.
- Adding vinegar to baking soda will produce a gas. If the liquid is evaporated, a salt will remain.
- When steel wool is exposed to water, rust is formed.

It is not essential for students to know the conditions for a chemical change or reaction to occur.

Assessment Guidelines:
The objective of this indicator is to *illustrate* the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated; therefore, the primary focus of assessment should be to give or use illustrations such as pictures, diagrams, or word descriptions showing that a chemical change has occurred when substances were mixed together. However, appropriate assessments should also require students to *identify* substances that are chemically combined from a mixture because they cannot easily be separated; or *recognize* chemically combined mixtures as new substances that cannot easily be separated.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.8 Explain how the mixing and dissolving of foreign substances is related to the pollution of the water, air, and soil.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.1), students were introduced to the concept of sediment when they classified rocks and soils. They were also introduced to Earth's water features (3-3.5). In 4th grade (4-2.6), students explained how organisms cause changes in their environments (for example, humans polluting the air and dumping toxins into waterways). In 7th grade (7-4.6), students will explain the importance of conservation of resources (including water, air, and soil).

It is essential for students to know that foreign substances can mix with and dissolve in water, air, and soil resulting in pollution.

- These foreign substances are often produced as a result of activities associated with industry, agriculture, burning fossil fuels, or other processes associated with human activities.
- The greater the amount of the foreign substance, the more concentrated or harmful the pollution can be.

It is not essential for students to know exactly what kinds of foreign substances are responsible for pollution of water, air, and soil. Students do not need to know about point and nonpoint sources of pollution.

Assessment Guidelines:
The objective of this indicator is to *explain* how the mixing and dissolving of foreign substances is related to the pollution of water, air, and soil; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how foreign substances cause pollution of water, air, or soil pollution when mixed or dissolved in them. However, appropriate assessments should also require students to *recognize* pollution of water, air, and soil as being formed from foreign substances mixed or dissolved in them; or *summarize* the relationship between water, air, and soil pollutions and the mixing and dissolving of foreign substances.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.1 Illustrate the effects of force (including magnetism, gravity, and friction) on motion.
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: In the 1st grade (1-5.2), students explained the importance of pushing and pulling to the motion of an object. In 3rd grade, students explained how the motion of an object is affected by the strength of a push or pull and the mass of the object (3-5.3) and the relationship between the motion of an object and the pull of gravity (3-5.4). In 2nd grade (2-5.2), students explained how the poles of magnets affect each other (that is, they attract and repel one another). In 8th grade, students will analyze the effects of forces (including gravity and friction) on the speed and direction of an object (8-5.3) and predict how varying the amount of force or mass will affect the motion of an object (8-5.4).

It is essential for students to know that a *force* is a push or pull. Forces can make things move faster, slower, stop, or change direction. Different forces (including magnetism, gravity, and friction) can affect motion.

Magnetism
- A force that acts at a distance and cannot be seen.
- Materials that create this force are said to be magnetic and are called *magnets*.
- The needle of a compass moves because of Earth's *magnetism*.
- When like poles (S-S or N-N) of magnets are near each other, the magnetic force causes the poles to repel, and the magnets push away from each other.
- When opposite poles (N-S or S-N) of magnets are near each other, the magnetic force causes the poles to attract, and the magnets pull toward each other.
- The closer the objects, the greater the magnetic force.
- The magnetic force is greatest at the poles of magnets.

Gravity
- A pull that attracts objects to each other.
- This attraction is not noticeable unless one of the objects is very large, for example a planet, a moon, or the Sun.
- The force of gravity between Earth and anything on it is extremely noticeable because the mass of Earth is so large. The pull of Earth's gravity makes any object fall to the ground.
- As the Moon goes around Earth, its gravity pulls on Earth causing water in the oceans to move toward the Moon.
- Earth's gravity also pulls on the Moon. This force of gravity keeps the Moon moving around Earth.
- Similarly, the pull of the Sun's gravity keeps Earth moving around the Sun.

Friction
- The force that opposes motion between two surfaces that are touching.
- The effect of friction can be observed as an object slides across a surface and slows down.
- The rougher the surfaces are, and the harder the surfaces press together, the more friction there will be.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

- Friction can be reduced by using *lubricants*, for example motor oil, wax, or grease, by making surfaces smoother, or by using rollers.
- Friction occurs in liquids and gases as well as between solids.
- Without friction, it would be very hard to slow or stop the motion of objects.

It is not essential for students to know the quantitative relationships involved in forces affecting the motion of objects.

Assessment Guidelines:
The objective of this indicator is to *illustrate* the effects of force on motion; therefore, the primary focus of assessment should be to give or use illustrations, including pictures, diagrams, or word descriptions, of how forces (including magnetism, gravity, and friction) affect the motion of objects. However, appropriate assessments should also require students to *summarize* information about how magnetism, gravity or friction affect the motion of objects; or *recognize* how these forces can affect the motion of objects.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.2 Summarize the motion of an object in terms of position, direction, and speed.
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade, students identified the location of an object relative to another object (1-5.1) and illustrated ways in which objects can move in terms of direction and speed (including straight forward, back and forth, fast or slow, zigzag, and circular) (1-5.4). In 3rd grade, students identified the position of an object relative to a reference point using position terms and a distance scale or measurement (3-5.1) and compared the motion of common objects in terms of speed and direction (3-5.2). Students will further develop these concepts in 8th grade (8-5.2) where they will develop the concept of speed quantitatively.

It is essential for students to know that motion is described in terms of position, direction, and speed as follows:

Position

- The *position* of an object is its location relative to another object (the reference point) for example "above", "below", "beside", "behind", "ahead of" plus the distance from the other object.
- The distance (length) from the reference point changes when the object moves.

Direction

- *Direction* of motion is the course or path that an object is moving and can be determined by reading a compass using the terms "north", "south", "east", or "west."
- Direction can also be described using the terms "right", or "left," "forward," or "toward" relative to another object, or "up", or "down" relative to Earth.

Speed

- A measure of how fast an object is moving.

NOTE TO TEACHER: Students should be able to measure the distance specific objects move in a given time. They can compare the relative speeds of different moving objects determining which is moving faster or slower.

It is not essential for students to know the concept of velocity (both speed and direction), or the concept of acceleration (changing speed). Students do not need to calculate speed.

Assessment Guidelines:
The objective of this indicator is to *summarize* the motion of an object in terms of position, direction, and speed; therefore, the primary focus of assessment should be to generalize major points about motion relative to position, direction, and speed. However, appropriate assessments should require students to *identify* the terms of position, direction, and speed and use them to describe motion; *illustrate* motion in terms of position, direction, and speed using drawings, diagrams, and word descriptions; or *interpret* a diagram of an object changing position over time in order to determine the speed of the object.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.3 Explain how unbalanced forces affect the rate and direction of motion in objects.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-5.1), students explained the importance of pushing and pulling to the motion of an object. In 3rd grade, students compared the motion of common objects in terms of speed and direction (3-5.2) and explained how the motion of an object is affected by the strength of a push or pull and the mass of the object (3-5.3). Students have not been introduced to the concept of unbalanced forces or rate of motion of objects in previous grade levels. Students will further develop the concepts of the effect of balanced and unbalanced forces on an object's motion in terms of magnitude and direction in 8th grade (8-5.6).

It is essential for students to know that unbalanced forces change the rate and direction of the motion of objects.

- Several forces can act on an object at the same time.
- Sometimes forces are balanced which means that they are equal in strength but opposite in direction.
- Balanced forces do not change the motion of objects only unbalanced forces cause changes in motion.
- An unbalanced force is one that does not have another force of equal magnitude and opposite direction off-setting it.
- *Rate of motion* is the speed of the object or how fast or slow the object is moving.
- Unbalanced forces can change the rate or direction of motion of an object in different ways:

Object at rest

- If an unbalanced force acts on an object at rest the object will move in the direction of the force.
- A stronger force (push or pull) will make it move faster.

Object in motion

- If an object is moving, an unbalanced force will change the motion of the object in different ways depending on how the force is applied. The unbalanced force may speed the object up, slow it down, or make it change directions.
  - If the force is applied in the same direction as the object is moving, the object will speed it up.
  - If the force is applied in the opposite direction as the object is moving, the object will slow it down or stop it.
  - If the force is applied to the side of the moving object, the object will turn.

It is not essential for students to know the difference between speed and velocity, or the concept of acceleration.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

Assessment Guidelines:

The objective of this indicator is to *explain* how unbalanced forces affect the rate and direction of motion in objects; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how the rate and direction of motion is affected by unbalanced forces. However, appropriate assessments should also require students to *identify* the meaning of unbalanced forces, rate, and direction of motion; *summarize* information about unbalanced forces and how they affect rate and direction of motion; or *illustrate* with drawings, diagrams, or word descriptions the effects of unbalanced force on an object.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.4 Explain ways to change the effect that friction has on the motion of objects (including changing the texture of the surface, changing the amount of surface area involved, and adding lubrication).
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of friction in previous grade levels. Students will further develop the concept of friction in 8th grade (8-5.3)

It is essential for students to know that friction is a force produced when objects are in contact with each other. Friction is a force that acts against motion. The following variables influence the affect of friction:

Texture of the surface
- *Rough surfaces* tend to create more friction.
- *Smooth surfaces* tend to create less friction.

Amount of surface area
- The amount of surface area affects the friction between objects in liquids and gases.
- The amount of surface area affects the friction on a moving object under the following circumstances: air resistance (such as the size of a parachute) or the resistance of an object as it glides through water (such as a boat).
- The amount of surface area in contact usually does not affect friction between two solids.

Lubrication
- *Lubrication,* for example oil or grease, reduces the effects of friction.
- Without lubrication, moving parts of machines would slow down or stop very quickly.

It is not essential for students to know why these factors affect friction.

Assessment Guidelines:
The objective of this indicator is to *explain* ways to change the effects of friction on the motion of objects; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the ways to change the effects of friction on motion including those listed in the indicator. However, appropriate assessments should also require students to *recognize* factors that affect friction; *illustrate* a diagram of objects moving to determine which factors are increasing friction to slow down or stop the motion; *summarize* major points about the factors that affect friction with their increasing or decreasing the effects; *infer* which factors are increasing or decreasing friction to slow down or speed up the motion of objects.

Forces and Motion

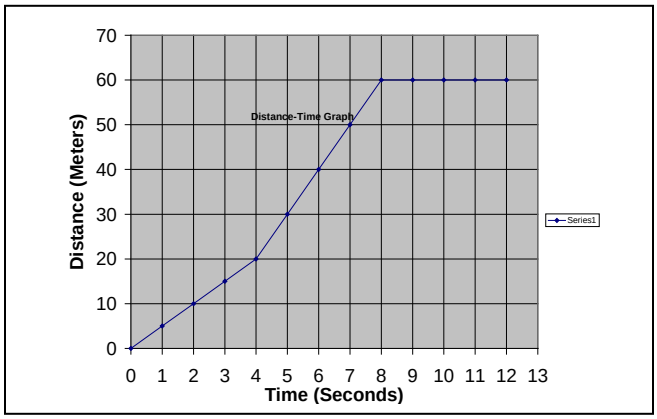
5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.5 Use a graph to illustrate the motion of an object.
Taxonomy level: 3.2-B, C Apply Procedural and Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of using a graph to illustrate motion of an object in previous grades. Students will further develop the concepts of graphing motion in 8th grade (8-5.1).

It is essential for students to construct a distance-time graph to illustrate the motion of an object. For example, given the following data collected from a moving object:

Time (Sec)	Distance (meters)
0	0
1	5
2	10
3	15
4	20
5	30
6	40
7	50
8	60
9	60
10	60
11	60



Distance-Time Graph

To construct a distance-time graph, follow the correct procedures for producing a graph:

- Correct placement of dependent and independent variables (DRY-MIX)
- Correct labeling of the axes
- Title the graph
- Correct placement of intervals

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

It is essential for students to interpret the motion of an object from studying a distance time graph, including:

- The total distance that the object has traveled after a certain amount of time
- The distance that the object travels during a particular time interval
- Determine if the object is moving or stationary during a particular time interval
- Compare the motion of the object during two time intervals (Based on the shape of the graph, is the object moving faster or slower?)

It is not essential for students to know how to construct the graph of time versus position from the data. They must only interpret the graph at this grade level as illustrating speed, faster speed, slower speed, and stopped motion.

Assessment Guidelines:

The objective of this indicator is to *use* a graph to illustrate the motion of an object; therefore, the primary focus of assessment should be to apply a procedure of using a graph to illustrate of the motion of objects. However, appropriate assessments should also require students to *infer* from the shape of a distance time graph whether an object is moving or not; or *compare* distance-time graphs to determine which object is moving faster.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.6 Explain how a change of force or a change in mass affects the motion of an object.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-5.3), students explained how the motion of common objects is affected by the strength of a push or pull and the mass of the object. They have not been introduced to the concept of a change in force or mass affecting the motion of an object in previous grades. They will further develop these concepts in 8th grade (8-5.4) when students will predict how varying the amount of force or mass will affect the motion of an object.

It is essential for students to know that the motion of an object can be affected by a change in force or a change in mass

Force

- If there are two objects with the same mass and one is acted on by a greater force than the other, the one acted on by the greater force will have the greatest change in speed.
- It will speed up the most or slow down the most in a given amount of time.

Mass

- If there are two objects, one with a greater mass than the other, and the same amount of force is applied to each object, the object with the lesser mass will have the greater change in speed.
- It will speed up or slow down more in a given amount of time.
- It is harder to change the speed of the object with the greater mass than the object with the lesser mass.

It is not essential for students to know that the change of speed of an object is called acceleration. Students also do not need to know the quantitative relationships among mass, acceleration, and force. Neither do they need to know the relationship between mass and inertia.

Assessment Guidelines:
The objective of this indicator is to *explain* how the motion of an object is affected by a change in force or mass of an object; therefore, the primary focus of assessment should be to a construct cause-and-effect model of how these factors affect motion of an object. However, appropriate assessments should also require students to *summarize* the effect on motion that a change in force or mass causes; *infer* from the factors whether they increase or decrease the rate of motion; *predict* how a given factor will affect the rate of motion; or *recognize* which factors increase rate of motion and which decrease rate of motion.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.1 Illustrate the effects of force (including magnetism, gravity, and friction) on motion.
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: In the 1st grade (1-5.2), students explained the importance of pushing and pulling to the motion of an object. In 3rd grade, students explained how the motion of an object is affected by the strength of a push or pull and the mass of the object (3-5.3) and the relationship between the motion of an object and the pull of gravity (3-5.4). In 2nd grade (2-5.2), students explained how the poles of magnets affect each other (that is, they attract and repel one another). In 8th grade, students will analyze the effects of forces (including gravity and friction) on the speed and direction of an object (8-5.3) and predict how varying the amount of force or mass will affect the motion of an object (8-5.4).

It is essential for students to know that a *force* is a push or pull. Forces can make things move faster, slower, stop, or change direction. Different forces (including magnetism, gravity, and friction) can affect motion.

Magnetism
- A force that acts at a distance and cannot be seen.
- Materials that create this force are said to be magnetic and are called *magnets*.
- The needle of a compass moves because of Earth's *magnetism*.
- When like poles (S-S or N-N) of magnets are near each other, the magnetic force causes the poles to repel, and the magnets push away from each other.
- When opposite poles (N-S or S-N) of magnets are near each other, the magnetic force causes the poles to attract, and the magnets pull toward each other.
- The closer the objects, the greater the magnetic force.
- The magnetic force is greatest at the poles of magnets.

Gravity
- A pull that attracts objects to each other.
- This attraction is not noticeable unless one of the objects is very large, for example a planet, a moon, or the Sun.
- The force of gravity between Earth and anything on it is extremely noticeable because the mass of Earth is so large. The pull of Earth's gravity makes any object fall to the ground.
- As the Moon goes around Earth, its gravity pulls on Earth causing water in the oceans to move toward the Moon.
- Earth's gravity also pulls on the Moon. This force of gravity keeps the Moon moving around Earth.
- Similarly, the pull of the Sun's gravity keeps Earth moving around the Sun.

Friction
- The force that opposes motion between two surfaces that are touching.
- The effect of friction can be observed as an object slides across a surface and slows down.
- The rougher the surfaces are, and the harder the surfaces press together, the more friction there will be.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

- Friction can be reduced by using *lubricants*, for example motor oil, wax, or grease, by making surfaces smoother, or by using rollers.
- Friction occurs in liquids and gases as well as between solids.
- Without friction, it would be very hard to slow or stop the motion of objects.

It is not essential for students to know the quantitative relationships involved in forces affecting the motion of objects.

Assessment Guidelines:
The objective of this indicator is to *illustrate* the effects of force on motion; therefore, the primary focus of assessment should be to give or use illustrations, including pictures, diagrams, or word descriptions, of how forces (including magnetism, gravity, and friction) affect the motion of objects. However, appropriate assessments should also require students to *summarize* information about how magnetism, gravity or friction affect the motion of objects; or *recognize* how these forces can affect the motion of objects.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.2 Summarize the motion of an object in terms of position, direction, and speed.
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade, students identified the location of an object relative to another object (1-5.1) and illustrated ways in which objects can move in terms of direction and speed (including straight forward, back and forth, fast or slow, zigzag, and circular) (1-5.4). In 3rd grade, students identified the position of an object relative to a reference point using position terms and a distance scale or measurement (3-5.1) and compared the motion of common objects in terms of speed and direction (3-5.2). Students will further develop these concepts in 8th grade (8-5.2) where they will develop the concept of speed quantitatively.

It is essential for students to know that motion is described in terms of position, direction, and speed as follows:

Position

- The *position* of an object is its location relative to another object (the reference point) for example "above", "below", "beside", "behind", "ahead of" plus the distance from the other object.
- The distance (length) from the reference point changes when the object moves.

Direction

- *Direction* of motion is the course or path that an object is moving and can be determined by reading a compass using the terms "north", "south", "east", or "west."
- Direction can also be described using the terms "right", or "left," "forward," or "toward" relative to another object, or "up", or "down" relative to Earth.

Speed

- A measure of how fast an object is moving.

NOTE TO TEACHER: Students should be able to measure the distance specific objects move in a given time. They can compare the relative speeds of different moving objects determining which is moving faster or slower.

It is not essential for students to know the concept of velocity (both speed and direction), or the concept of acceleration (changing speed). Students do not need to calculate speed.

Assessment Guidelines:
The objective of this indicator is to *summarize* the motion of an object in terms of position, direction, and speed; therefore, the primary focus of assessment should be to generalize major points about motion relative to position, direction, and speed. However, appropriate assessments should require students to *identify* the terms of position, direction, and speed and use them to describe motion; *illustrate* motion in terms of position, direction, and speed using drawings, diagrams, and word descriptions; or *interpret* a diagram of an object changing position over time in order to determine the speed of the object.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.3 Explain how unbalanced forces affect the rate and direction of motion in objects.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-5.1), students explained the importance of pushing and pulling to the motion of an object. In 3rd grade, students compared the motion of common objects in terms of speed and direction (3-5.2) and explained how the motion of an object is affected by the strength of a push or pull and the mass of the object (3-5.3). Students have not been introduced to the concept of unbalanced forces or rate of motion of objects in previous grade levels. Students will further develop the concepts of the effect of balanced and unbalanced forces on an object's motion in terms of magnitude and direction in 8th grade (8-5.6).

It is essential for students to know that unbalanced forces change the rate and direction of the motion of objects.

- Several forces can act on an object at the same time.
- Sometimes forces are balanced which means that they are equal in strength but opposite in direction.
- Balanced forces do not change the motion of objects only unbalanced forces cause changes in motion.
- An unbalanced force is one that does not have another force of equal magnitude and opposite direction off-setting it.
- *Rate of motion* is the speed of the object or how fast or slow the object is moving.
- Unbalanced forces can change the rate or direction of motion of an object in different ways:

Object at rest

- If an unbalanced force acts on an object at rest the object will move in the direction of the force.
- A stronger force (push or pull) will make it move faster.

Object in motion

- If an object is moving, an unbalanced force will change the motion of the object in different ways depending on how the force is applied. The unbalanced force may speed the object up, slow it down, or make it change directions.
  - If the force is applied in the same direction as the object is moving, the object will speed it up.
  - If the force is applied in the opposite direction as the object is moving, the object will slow it down or stop it.
  - If the force is applied to the side of the moving object, the object will turn.

It is not essential for students to know the difference between speed and velocity, or the concept of acceleration.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

Assessment Guidelines:

The objective of this indicator is to *explain* how unbalanced forces affect the rate and direction of motion in objects; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how the rate and direction of motion is affected by unbalanced forces. However, appropriate assessments should also require students to *identify* the meaning of unbalanced forces, rate, and direction of motion; *summarize* information about unbalanced forces and how they affect rate and direction of motion; or *illustrate* with drawings, diagrams, or word descriptions the effects of unbalanced force on an object.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.4 Explain ways to change the effect that friction has on the motion of objects (including changing the texture of the surface, changing the amount of surface area involved, and adding lubrication).
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of friction in previous grade levels. Students will further develop the concept of friction in 8th grade (8-5.3)

It is essential for students to know that friction is a force produced when objects are in contact with each other. Friction is a force that acts against motion. The following variables influence the affect of friction:

Texture of the surface
- *Rough surfaces* tend to create more friction.
- *Smooth surfaces* tend to create less friction.

Amount of surface area
- The amount of surface area affects the friction between objects in liquids and gases.
- The amount of surface area affects the friction on a moving object under the following circumstances: air resistance (such as the size of a parachute) or the resistance of an object as it glides through water (such as a boat).
- The amount of surface area in contact usually does not affect friction between two solids.

Lubrication
- *Lubrication,* for example oil or grease, reduces the effects of friction.
- Without lubrication, moving parts of machines would slow down or stop very quickly.

It is not essential for students to know why these factors affect friction.

Assessment Guidelines:
The objective of this indicator is to *explain* ways to change the effects of friction on the motion of objects; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the ways to change the effects of friction on motion including those listed in the indicator. However, appropriate assessments should also require students to *recognize* factors that affect friction; *illustrate* a diagram of objects moving to determine which factors are increasing friction to slow down or stop the motion; *summarize* major points about the factors that affect friction with their increasing or decreasing the effects; *infer* which factors are increasing or decreasing friction to slow down or speed up the motion of objects.

Forces and Motion

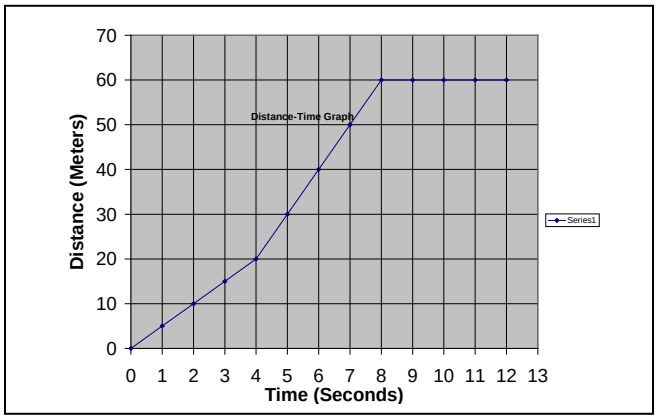
5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.5 Use a graph to illustrate the motion of an object.
Taxonomy level: 3.2-B, C Apply Procedural and Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of using a graph to illustrate motion of an object in previous grades. Students will further develop the concepts of graphing motion in 8th grade (8-5.1).

It is essential for students to construct a distance-time graph to illustrate the motion of an object. For example, given the following data collected from a moving object:

Time (Sec)	Distance (meters)
0	0
1	5
2	10
3	15
4	20
5	30
6	40
7	50
8	60
9	60
10	60
11	60



Distance-Time Graph

To construct a distance-time graph, follow the correct procedures for producing a graph:

- Correct placement of dependent and independent variables (DRY-MIX)
- Correct labeling of the axes
- Title the graph
- Correct placement of intervals

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

It is essential for students to interpret the motion of an object from studying a distance time graph, including:

- The total distance that the object has traveled after a certain amount of time
- The distance that the object travels during a particular time interval
- Determine if the object is moving or stationary during a particular time interval
- Compare the motion of the object during two time intervals (Based on the shape of the graph, is the object moving faster or slower?)

It is not essential for students to know how to construct the graph of time versus position from the data. They must only interpret the graph at this grade level as illustrating speed, faster speed, slower speed, and stopped motion.

Assessment Guidelines:

The objective of this indicator is to *use* a graph to illustrate the motion of an object; therefore, the primary focus of assessment should be to apply a procedure of using a graph to illustrate of the motion of objects. However, appropriate assessments should also require students to *infer* from the shape of a distance time graph whether an object is moving or not; or *compare* distance-time graphs to determine which object is moving faster.

Forces and Motion

5-5 The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

5-5.6 Explain how a change of force or a change in mass affects the motion of an object.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-5.3), students explained how the motion of common objects is affected by the strength of a push or pull and the mass of the object. They have not been introduced to the concept of a change in force or mass affecting the motion of an object in previous grades. They will further develop these concepts in 8th grade (8-5.4) when students will predict how varying the amount of force or mass will affect the motion of an object.

It is essential for students to know that the motion of an object can be affected by a change in force or a change in mass

Force

- If there are two objects with the same mass and one is acted on by a greater force than the other, the one acted on by the greater force will have the greatest change in speed.
- It will speed up the most or slow down the most in a given amount of time.

Mass

- If there are two objects, one with a greater mass than the other, and the same amount of force is applied to each object, the object with the lesser mass will have the greater change in speed.
- It will speed up or slow down more in a given amount of time.
- It is harder to change the speed of the object with the greater mass than the object with the lesser mass.

It is not essential for students to know that the change of speed of an object is called acceleration. Students also do not need to know the quantitative relationships among mass, acceleration, and force. Neither do they need to know the relationship between mass and inertia.

Assessment Guidelines:
The objective of this indicator is to *explain* how the motion of an object is affected by a change in force or mass of an object; therefore, the primary focus of assessment should be to a construct cause-and-effect model of how these factors affect motion of an object. However, appropriate assessments should also require students to *summarize* the effect on motion that a change in force or mass causes; *infer* from the factors whether they increase or decrease the rate of motion; *predict* how a given factor will affect the rate of motion; or *recognize* which factors increase rate of motion and which decrease rate of motion.