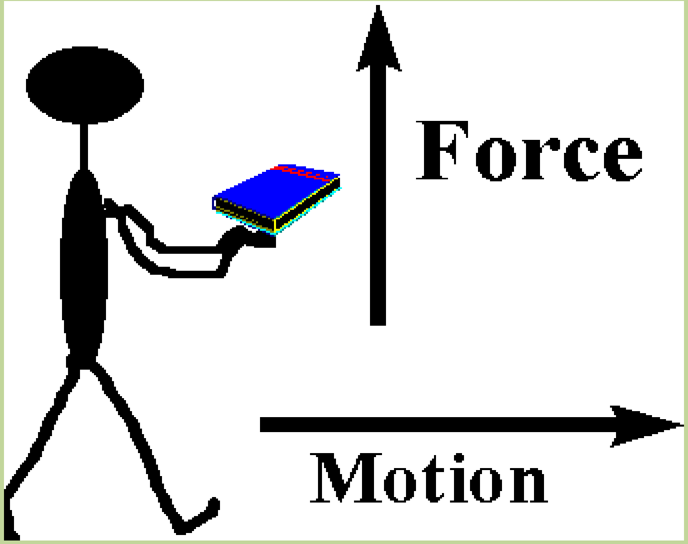
Science Unit 4 Plan
Grade 6

Force and Motion



Number of Days for Unit: 25 days

Unit 4: Force and Motion

NJDOE -Model Curriculum – NGSS

How can we predict the motion of an object?

Students use *system and system models* and *stability and change* to understanding ideas related to why some objects will keep moving and why objects fall to the ground. Students apply Newton's third law of motion to related forces to explain the motion of objects. Students also apply an engineering practice and concept to solve a problem caused when objects collide. The crosscutting concepts of *system and system models* and *stability and change* provide a framework for understanding the disciplinary core ideas. Students demonstrate proficiency in *asking questions*, *planning and carrying out investigations, designing solutions, engaging in argument from evidence*, *developing and using models,* and *constructing explanations and designing solutions*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on MS-PS2-1, MS-PS2-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4.

Student Objectives:
Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. * *[Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]* **(MS-PS2-1)**
Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. *[Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]* **(MS-PS2-2)**

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1)
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2)
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (MS-ETS1-4)
Concepts:

Part A:

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).
- Models can be used to represent the motion of objects in colliding systems and their interactions, such as inputs, processes, and outputs, as well as energy and matter flows within systems.
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values, by the findings of scientific research and by differences in such factors as climate, natural resources, and economic conditions.
- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful.

Formative Assessment:

Students who understand the concepts are able to:

- Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.
- Define a design problem involving the motion of two colliding objects that can be solved through the development of an object, tool, process, or system and that includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
- Evaluate competing design solutions involving the motion of two colliding objects based on jointly developed and

agreed-upon design criteria.

- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.
  - Analyze and interpret data to determine similarities and differences in findings.

- The change in an object's motion depends on balanced (Newton's first law) and unbalanced forces in a system Evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object includes qualitative comparisons of forces, mass, and changes in motion (Newton's second law); frame of reference; and specification of units
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change.
- The greater the mass of the object, the greater the force needed to achieve the same change in motion.
- For any given object, a larger force causes a larger change in motion.

Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

Formative Assessments:

Students who understand the concepts are able to:

- Plan an investigation individually and collaboratively to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- Design an investigation and identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- Make logical and conceptual connections between evidence and explanations.

Examine the changes over time and forces at different scales to explain the stability and change in designed systems

NGSS

Performance Expectations:

Students who demonstrate understanding can:

MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.* [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [*Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.*]

MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [*Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.*]

Science and Engineering Practices

3. **Planning and Carrying Out Investigations**
   - Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS2-2)

6. **Constructing Explanations and Designing Solutions**
   - Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1)

1. **Asking Questions and Defining Problems**
   - Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)

7. **Engaging in Argument from Evidence**
   - Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)

Disciplinary Core Ideas:

PS2.A: Forces and Motion

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

ETS1.A: Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)

ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2)
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4)

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)

The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

Cross Cutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1)

Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-PS2-1)
- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1)
- The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

Assessments

Suggested Formative Assessments:

- Participation in investigation (following the procedures of the lab and scientific drawing) and class discussion
- Journals (observations, claims and evidence, conclusion)
- Lab Report Responses to reading materials
- Notebook Investigation Entries
- Student Observations
- Anecdotal Notes during Performance task
- Homework

Summative Assessments:
Pre-Assessment
Essay Responses
Projects
Post Assessment

Discovery Education Tech Book Unit Overview

Part A. Force and Motion - Straight Line Motion
Part B. Interaction of Force and Mass

Teachers begin each part of the unit by **engaging** students in a phenomenon/anchoring event. The anchoring event is a specific event in which students observe and provide their explanation of the event. More information about anchoring events can be found here: goo.gl/ULVptn As students learn about forces and motion they will take their learning and connect it back to their original explanation of the anchoring event. Groups are an effective method for working with explanatory models. More information about them can be found here: http://ambitiousscienceteaching.org/tools-face-to-face/#Smallgroup

After presenting students with the event, students will **explore** Newton's Laws through reading core interactive text, inquiry based investigations, and videos. Listed below are high leverage resources teachers can use. Paired with the resources are links to instructional strategies that would be effective for implementation. Teachers are encouraged to have students work in a guided inquiry style lesson, but if students need additional structure the teacher should provide that. Additional detailed instructional ideas can be found at Part A: https://google.discoveryeducation.com/learn/techbook/units/aca7980d-a6c7-475d-9d82-87d45a377a7e/concepts/26f1b297-b9d6-49e4-b3c3-b4f4e0150c90/lesson/overview and Part B; https://google.discoveryeducation.com/learn/techbook/units/aca7980d-a6c7-475d-9d82-87d45a377a7e/concepts/46b1fc10-8fdc-4e55-a6b6-14b34ae5cb71/lesson these "model lessons" should not be implemented as is, but can be a valuable resource for teachers looking for strategies and suggestions as they craft their plan. The class should keep a summary table for all learning experiences. More on summary tables with samples can be found at: http://ambitiousscienceteaching.org/tools-face-to-face/#Summtable

Students will provide scientific **explanation** using their conceptual understandings of Newton's Laws to explain phenomena through daily documentation. Students should regularly revisit and revise their original explanations around the phenomena.   Strategies for working on and improving scientific explanations can be found here: http://ambitiousscienceteaching.org/tools-face-to-face/#Sticky

Students will finalize their scientific explanations of the anchoring event. They should use a teacher created rubric to evaluate their explanation and include evidence to support their claim. The rubric listed in the explain tab of Discovery Education is a starting point for the rubric, and could be used, but the teacher may want to add specific details related to force and motion. Student's original and revised explanations serve as formative assessments measuring progress, while the final explanation should be the summative assessment. Students could submit this as an essay, a digital media project, or some other representation that allows them to communicate their claim, evidence, and reasoning. https://google.discoveryeducation.com/learn/techbook/units/aca7980d-a6c7-475d-9d82-87d45a377a7e/concepts/46b1fc10-8fdc-4e55-a6b6-14b34ae5cb71/tabs/0df56444-5400-41eb-a6ce-de52b7efb950

**What students should understand: (To be shown in their final products)- comes from the evidence statement*

Given a problem to solve involving the collision of two objects, students design a solution to protect one of the colliding objects. Students will identify the components within the system and collision, the force exerted on the second object by the first object, how newton's third law will be applied to designing the solution, and the technologies (any human made material or device) that will be used in the solution. Students will describe how specific criteria and constraints are applied to the solution. They should describe how the criteria are appropriate and the constraints, (which may include but is not limited to; cost, mass and speed of objects, time, materials.) Students will use their knowledge of Newton's Third Law to systematically determine how well the design meets the specified criteria and constraints. They will identify the value of the solution to society, and determine how the choice of technologies that are used in the design is affected by the constraints of the problem and the limits of technological advances.

Key Vocabulary
speed, inertia, action, force, acceleration, measure, position, velocity, motion, action, work, thrust, weight, mass, inertia, wedge, friction, force,conservation of mass, acceleration, wheel, lever, simple machine, balance, gravity
Discovery Education Tech Book - Connection
Course: Grade 6-8 Physical Science NGSS Matter and Energy **Unit:** Forces and Motion **Concepts:** Straight Line Motions Interactions of Force and Mass
High Leverage Learning Experiences and Resources
Part A. Straight Line Motion ***ENGAGE*** ***Session 1 Introduction of Anchoring Event/Engage/Opening:*** During the engage session(s), events are used to capture students interest. During this time, you should uncover what students know and think about the topic as well as determine their misconceptions. Engagement activities might include video segments, a reading, a demonstration, or other activity that piques students' curiosity. ***Anchoring Event*** The teacher will engage students in an anchoring event (relevant experience/phenomena) that relates to the topic of forces and motion. Several suggestions are listed below. For students to create an explanation of the phenomena they will need to learn about several topics over several days. Day one is the presentation of the topic and student's initial explanations. Working in small groups students should create a visual explanation of the anchoring event. **[SEP 1, 2, 6, 7, 8]**

Recommended Resources for Anchoring Events:

1. Show the segment "Inertia in Action" (show without sound), and have students create an explanatory model where they are tasked with explaining motion and events of the rear end collision. Elicit student thinking around the collision and why the driver's body moved the way he did. **Do not use sound** because they explain some of the concepts involved in the collision. Use questioning practices and avoid providing any details or information for the students. The goal of the activity is for students to develop and share their current thinking. Inertia in Action: https://google.discoveryeducation.com/player/view/assetGuid/2b2b6639-d4ff-4a9f-b114-cca9e73ce015
2. Show an image of two football players on impact during a game and have students create an explanatory model where they are tasked with explaining the motions and event. Elicit student thinking around the collision. Use questioning practices and avoid providing any details or information for the students. The goal of the activity is for students to develop and share their current thinking.
3. Show the video segment "Demonstrations of Inertia" (Show without sound) and have students create an explanatory model where they are tasked with explaining the motions and event. Elicit student thinking around the collision. Use questioning practices and avoid providing any details or information for the students. The goal of the activity is for students to develop and share their current thinking. Demonstrations of Inertia Link: https://google.discoveryeducation.com/player/view/assetGuid/4e02ca4f-e320-4e13-91ce-9c18be139437

Additional Links

Inquiry Problem: Forces
https://google.discoveryeducation.com/player/view/assetGuid/d9d3bc3e-43bf-4ba2-ae4b-df7871bb6d6f

Lesson Questions:

- What is motion?
- What causes an object to speed up or slow down?
- How can we describe the motion of an object?

EXPLORE

Sessions Two-Three

Students will develop their current understanding of Newton's Third Laws and its fundamental concepts, generate new ideas and begin developing their own questions. Students should document thinking, understandings and questions. Students should revisit and revise their original explanation regularly. In the **EXPLORATION** stage, students get directly involved with the scientific phenomena surrounding the motion of objects during collisions. As they work together in teams, students build a set of common experiences which prompts sharing and communicating. The teacher acts as a facilitator, providing materials and guiding the students' focus. The students' inquiry process drives the instruction during. Students are actively learning through inquiry-based science instruction and engineering challenges. Emphasis is placed on: Questioning, Data Analysis and Critical Thinking. Through self-designed and guided exploration students make hypotheses, test their own predictions, and draw their own conclusions. Using the anchoring event as a frame, they gather explore concepts and information necessary to design a solution to protect an object in a collision.

The Teacher should begin with Hands-on-Activities and then have the students use the resources listed to create learning experiences. Listed are some effective integration strategies for digital media and text that you may consider using. The performance expectation requires students to use resources to conduct research and gather evidence. ***The students should summarize their evidence after each learning experience, relate it back to the anchoring event, and add details to their explanation.***

Formative Assessment: Students will demonstrate understanding of motion by listing examples of motion and explaining what causes objects to move.

Exploratory Resources:

Hands-On Activities

Students will conduct Hands-On Investigations while documenting their work in their science notebooks and completing the student lab reports. Teacher will encourage students to share their ideas about the forces acting on the marble while it was moving. Students should understand that gravity was the force that acted to move, or accelerate, the marble. Students should also understand that friction was the force that acted to slow the marble.

"Massive Motion"
https://google.discoveryeducation.com/player/view/assetGuid/980cc394-3f7f-4443-87af-ffe7bcd81467

“Investigating Straight Line Motion”
https://google.discoveryeducation.com/player/view/assetGuid/2b59ff7f-2db5-495e-9f75-32ba54587d75

“Measuring Changes In Motion”
https://google.discoveryeducation.com/player/view/assetGuid/fe55839a-eddc-423a-92a4-10a9b225710e

“Measuring Constant Velocity”
https://google.discoveryeducation.com/player/view/assetGuid/05b6db46-b16a-4438-a110-b6bcce2a1dc8

“Straight Line Motion: https://google.discoveryeducation.com/learn/techbook/units/aca7980d-a6c7-475d-9d82-87d45a377a7e/concepts/26f1b297-b9d6-49e4-b3c3-b4f4e0150c90/tabs/759da9a7-2edf-4cde-9515-7081ca990764

Core Interactive Text:

Students will read the core interactive text using one of the literacy strategies below, or a strategy that the teach selects that is effective for their students. As students read they should cite evidence that will help them explain the motion during the rear end collision. Students should note the source of their evidence.

As a class, they students should summarize their learning and add evidence to their summary table.

Teacher Resources:
Literacy Strategies:
Encourage students to create their own notes to summarize the text. They can use the highlight and take notes features of tech-book to fill in notes in their digital notebook.

Think-Aloud:
The teacher can model reading the text, highlighting, and annotating the text with purpose. Talking through their cognitive processes. More about think-a-louds can be found at: http://www.readingrockets.org/strategies/think_alouds

Directed Reading Thinking Activity:
Informational text predicting and reading activity to build comprehension.
http://www.readingrockets.org/strategies/drta

Interactives:
"On The Move" (Frames of Reference)
https://google.discoveryeducation.com/player/view/assetGuid/720d98dd-a03f-489d-b4ca-0ccfb67bdade
Students should use the interactive to explore the concept of "Frames of Reference." Students should experiment with different settings and discuss the patterns that they see. Encourage students to relate the motion of the ball with the motion of the man in the car collision. How are they similar, and how are they different? What evidence supports their findings? Student could use the student work sheet under materials, but the teacher should have the students participate in a discussion as a small group about their findings and how they relate back to the anchoring phenomenon. As a class, students should summarize their learning and add evidence to their summary table.

Model Revisit:
Students should revisit their initial scientific explanatory model from day one. Students should use evidence from the summary table to connect their new learning to the model and refine their model to better explain the motion of the man in the collision.

"Newton's Laws"
https://google.discoveryeducation.com/learn/techbook/units/ACA7980D-A6C7-475D-9D82-87D45A377A7E/concepts/8007B839-3524-4F05-9916-1D67136B0760

"Interaction of Force and Mass"
https://google.discoveryeducation.com/learn/techbook/units/aca7980d-a6c7-475d-9d82-87d45a377a7e/concepts/46b1fc10-8fdc-4e55-a6b6-14b34ae5cb71/tabs/759da9a7-2edf-4cde-9515-7081ca990764

Interactives:
"Monster Truck Pull" (Introduces the concept of adding forces and vectors)
https://google.discoveryeducation.com/player/view/assetGuid/394e92c1-f719-4162-b24b-ec123d15c0b5

Videos:
"Facts about Forces"
https://google.discoveryeducation.com/player/view/assetGuid/9eda03c8-6c3d-4865-8c2c-e4702b3b1fd4

"Principles of Motion"
https://google.discoveryeducation.com/player/view/assetGuid/05c918a6-959c-46e9-9461-0048de9857dd

"Friction on Ground and The Air"
https://ggogle.discoveryeducation.com/learn/videos/b3a5e855-62e4-4a76-9440-144207d54211?hasLocalHost=false

"Laws of Motion"
https://google.discoveryeducation.com/player/view/assetGuid/4efe2918-15a6-49f3-aa3c-0c5a0edb4c0e

"Newton's First Law of Motion"
https://google.discoveryeducation.com/player/view/assetGuid/84a8ad43-365d-4f55-99be-1115263077d2

"Basic Principles of Force"
https://google.discoveryeducation.com/player/view/assetGuid/4c4c9138-5ca0-4ffc-a40d-66a806fee112

"Forces and Vectors"
https://google.discoveryeducation.com/player/view/assetGuid/f454bf0d-420e-4973-b066-464aadc43d51

"Newton's Second Law"
https://google.discoveryeducation.com/player/view/assetGuid/c4c8cfc3-5b3b-4b1f-9ce6-9348f6ffa6b0

Media Integration Strategies:
Match a strategy with the videos as is appropriate for students and their needs. Some recommended strategies are:

"Tweet Tweet" (Students discuss a video and the content in 140 characters on sticky-notes)
https://google.discoveryeducation.com/player/view/assetGuid/d577707d-8e6b-43f7-9082-0e4218c8279b

"Make It Concrete" (Students demonstrate understanding through "poems" in the shape of relevant objects)
https://google.discoveryeducation.com/player/view/assetGuid/7d2281f6-8d5b-48d8-b351-bb17edc63f02

"Silence Is Golden" (Students view videos w/o sound and make predictions and inferences about the content and focus on the visual elements)

https://google.discoveryeducation.com/player/view/assetGuid/a8448652-4378-4273-8aae-9b1059f273dd

Reading Passages:
"Look Out Below"
https://google.discoveryeducation.com/player/view/assetGuid/138B9382-922C-4CDB-B8A8-29B5700C23F9

"Seatbelt Science and Safety"
https://google.discoveryeducation.com/player/view/assetGuid/129ef46a-6a49-4b06-99b6-8f1d2e28d861

Literacy Strategies:
"Reciprocal Teaching" Asks students to take on different roles as they group read through a task.
http://www.readingrockets.org/strategies/reciprocal_teaching

"ReQuest" Reciprocal Questioning, where students read with a partner, generate, and answer questions.
http://www.readingeducator.com/strategies/request.htm

Songs:
"Newton's First Law with Velocity, Acceleration and Momentum"
https://google.discoveryeducation.com/player/view/assetGuid/8b5bf98c-5152-4c39-8f7d-2c3dead4ae11

Have students create a music video or dance routine for the song. Or, consider a paper slide video. More about paper slides can be found at: https://google.discoveryeducation.com/player/view/assetGuid/a60685c1-c2c4-4c67-abbc-fa3467a0b75b

Formative Assessment: At the end of day three have students revisit their explanation(model) and adjust, modify, add to it.

EXPLAIN
Session Four -Six
In the explain sessions students are provided with opportunities to communicate what they have learned so far and figure out what it means. Students begin to; 1) communicate what they have learned using scientific vocabulary in context, 2) use scientific language which provides motivation for sequencing events into a logical format and 3)correct

and or redirect any misconceptions. Communication occurs between peers, with the facilitator, and through the reflective process. Once students build their own understanding, they help summarize or EXPLAIN their own ideas.

Teacher Resources:

Interactive Glossary Activity

1. Have each student create a 2-column chart with the key vocabulary terms listed in the first column.
2. Tell students that they can use the chart to write definitions of the terms as they learn about them from the resources.
3. Encourage students to also take notes on separate paper using the essential questions as a guide.
4. Have students complete the Vocabulary Chart for the term.

Interactive Video Activity

1. Have students begin by exploring the interactive video Constant Speed). You may wish to have students work in groups, depending on available computer resources.
2. Challenge students to find as many of the 35 interactive features in the video as they can. Remind students to read each interactive feature carefully and decide if it contains key information that they might use to answer an lesson question or define a key vocabulary term. Tell students to pause the video while they read the interactive feature so that they do not miss any content and add any evidence that they uncover to their scientific explanations.
3. When students have completed the video, ask them to review their notes and discuss the answers to the lesson questions and the meanings to the key vocabulary terms. Tell them that they will explore two more resources that will help them fill in any gaps.

Video Segments Activity

1. Have students view the video segment. Newton's First Law of Motion
2. Ask students how Newton's First Law describes the motion of objects.
3. Ask students to explain why objects on Earth don't seem to stay in motion. Guide them to understand that friction and gravity often act as unbalanced forces that slow or stop moving objects on Earth.
4. Have students complete the Evaluation Questions

Tell students how much time they will have to complete the exploration and the student worksheet for the activities above. Explain how students should proceed:

- Follow the instructions on the student worksheet to perform the exploration.
- Complete the findings Chart.
- Complete the Check for Understanding Questions.
- Tell students to begin the exploration.
- When time is up, review the Check for Understanding questions.

Additional resources to help students understand the Lesson Questions "What is motion? What causes an object to speed up or slow down? How can we describe the motion of an object?" can be found in the Explore More Resources section of the Explore tab.

- Reading Passage: Forces and Motion
- Reading Passage: Oceans: Ocean Motion
- Reading Passage: Objects in Motion
- Reading Passage: Motion: Gravity in Motion
- Reading Passage: Getting to Know Straight Line Motion
- Video Segment: Inertia
- Video Segment: First Law of Motion
- Video Segment: Constant Motion
- Video Segment: Speed, Velocity, Acceleration and Deceleration
- Video Segment: Facts About Forces
- Reading Passage: Spigot Science: Motion: The Laws of Motion
- Reading Passage: Getting to Know Direction of Motion
- Reading Passage: Spigot Science: Motion: How our Bodies Move

Explain

1. Students will use the evidence that they collected in the Explore session to complete page 2 of the Scientific Explanation activity sheet (sections "Claim" and "Explanation").
2. Students will share their explanation with classmates.
3. Students and/or teams should revise or enhance their own explanations after sharing and exploring those of their classmates.

Three-Dimensional Learning in Focus

1. During the Scientific Explanation activity students are to draw on the evidence that they collected during Explore and create a Scientific Explanation.
2. Students must now analyze their evidence, make a claim about the evidence, and finally tie their evidence to their claim using logical reasoning.
3. When students complete the student guide that goes with the interactive resource, they are asked to answer three questions and cite evidence for their explanation to the three questions.
4. When students complete the writing of their Scientific Explanation, they should then share them, critique others', and refine their own as needed.

Formative Assessment: At the end of day six, have students revisit their explanation(model) and adjust, modify, add to it.

***ELABORATE* (45 minutes)**

Session Seven-Nine

Students engage in elaboration activities which will help them correct any remaining misconceptions and generalize concepts in a broader context. These activities will challenge students to apply, extend, or elaborate upon concepts and skills in a new situation, resulting in deeper understanding.

The focus of this section of the lesson is to have students create connections between their observations and research and the outside world.

Teacher Resources:

Optional Project #1

To help your students apply their understanding of Straight Line Motion, have them complete some or all of the following projects. The time required to complete each project will vary; some may require students to work outside the classroom.

1. Students can work individually to investigate the forces acting to move a skydiver using Look Out Below! as a resource.
2. Students can write a brochure advertising a skydiving experience for beginners that includes information about what

beginning skydivers should expect in terms of motion and the forces acting on them.

3. Ask students to present their findings to the class.

4. In this investigation, students create a brochure to communicate how the motion of skydivers are affected by the forces acting on them. (Disciplinary Core Ideas: PS2.A Forces and Motion and Crosscutting Concept: Stability and Change, Cause and Effect, RST.6-8.1, WHST 6-8.1, RST.6-8.9, MP.2) (Science and Engineering Practices: Obtaining, Evaluating and Communicating Information, Scientific Knowledge is Based on Empirical Evidence).

Optional Project #2

1. Ask students to watch the video Thermal Motion Sensor.
2. Ask students to use Board Builder tool to create a poster illustrating how a motion detector is triggered by body temperature.

Optional Project #3

1. Have students investigate the motion of baseballs during different pitches using The Physics of Pitching as a resource.
2. Students can use Board Builder to create a board presentation showing how air resistance (friction from air) resulting from spin causes an unbalanced force that causes the ball to change its motion.

Optional Project #4

1. Have students view the video segment Bodies in Motion.
2. Have students research different types of automobile brakes (disk, anti-lock, drum, and emergency) to find out how they slow the motion of a car.
3. Have students complete a summary frames organizer to record information on the effectiveness of each type of brake.
4. Ask students to present their findings to the class.

***EVALUATE* (45 minutes)**

Session Ten

Students understanding of concepts and their proficiency with various skills will be evaluated during this session. A variety of formal and informal procedures to assess conceptual understanding and progress toward learning outcomes will be used. The evaluation session also provides an opportunity for students to test their own understanding and skills.

Summative Assessments

1. Review Sheet: Students may review the information in this section using the Straight Line Motion Review Sheet.
2. Using the Brief Constructed Response (BCR), students will be assessed on PS2.A by explaining that motion is a change of position over time, that motion is the result of force acting upon an object and that motion is relative to the observer and other objects. Have students complete the Brief Constructed Response Link.
3. Have students also complete the Performance Based Assessment
4. You may also wish to assign the online concept assessment and use the results in the student's reports to guide you in assigning remediation to students if needed.

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Part 2 Interactions Force and Mass

Session Eleven

Engage: (15-20 minutes)

During this engage session, students will activate prior knowledge about force by participating in an in-class demonstration. They will also watch a video segment about net forces which will stimulate interest. During this time you should uncover what students know and think about the topic as well as determine their misconceptions.

Activate Prior Knowledge

- Have a student volunteer's jump lightly into the air. Ask students to describe what they see. Students may be able to explain that the student exerted a force on the ground to move up, and gravity pulled him/her back down. Ask students: What did the student need to do to leave the ground? At this point, accept all answers and make note of any misconceptions.

Formative Assessment: Save this list of students' thoughts and return to it throughout the lesson to modify and refine ideas as appropriate.

Stimulate Interest

- Have students watch the video segment: Principles of Motion https://app.discoveryeducation.com/player/view/assetGuid/05C918A6-959C-46E9-9461-0048DE9857DD. Have students use the Web/Concept Map Graphic Organizer https://app.discoveryeducation.com/player/view/assetGuid/33504938-2872-4353-91D4-D05DE9DC3B88. to answer the guided question How are forces related to the motion of objects?

- After students have viewed the video segment and recorded their ideas, place them in pairs to discuss their thoughts about forces and motion. Finally, post the lesson questions that constitute what students will be learning. Students may read them or you may wish to read them aloud together.

1. What happens when two unbalanced forces act on an object?
2. What kinds of forces can act on an object?

- Have students complete page 1 (What was the question that you wanted to answer? And "Prior Knowledge) of the Scientific Explanation document. http://app.discoveryeducation.com/player/view/assetGuid/846BE31F-B3D8-478B-9AE0-32C2297CE5DCI

- Introduce the Evidence section on page 2. Explain to students that they will be adding to this section later in the lesson. The focus of this section of the lesson is to research balanced and unbalanced forces and their effects on the motion of objects. As they progress through the session, students cite the specific textual evidence that supports their analysis of the content presented in each resource.

- Introduce the vocabulary terms that relate to non-visible light. (Action, force, fulcrum, inertia, lever, mass, simple machine, thrust, weight and work). Ask students to turn and talk to a neighbor to describe their understanding of each term.

- Have students then use the Interactive Glossary to assess and modify their understanding. Have students begin to complete the Vocabulary Chart for each term, adding to it as they progress through the lesson.

Core Interactive Text.

- Have students cite evidence to answer the Lesson Questions as they read and add text to the Scientific Explanation. Interaction of Force and Mass https://app.discoveryeducation.com/player/view/assetGuid/6644A6E2-1FAA-4017-B7E1-A754739EC9FD

Differentiation and Support Tips

- Have students use the Speak Text and Listen tools to reinforce pronunciation and clarify the text as they read.
- Have students read in Spanish or French if that is more helpful.

Explore:

Sessions Twelve and Thirteen

The focus of these section of the lesson is to clearly communicate explanations and answers to the lesson questions. Students are guided to compare information about how an object is affected by forces applied to that object. As they progress through the session, students cite the specific textual evidence that supports their analysis of the content presented in each resource.

- Have students use the T-chart graphic organizer. Students should label their charts "name of force" and "description of force." Newton's Second Law of Motion (2:06) http://app.discoveryeducation.com/player/view/assetGuid/0B7E0350-7840-4F57-B76C-240D6D62E8F9

- Have students view the video segments. Constant Motion and Constant Motion and Physical Science: The Basics: Grades 06-08 ("Magnetism" segment) and Torque: Twisting Force (3:47)As students view the video segments, they should fill in their charts. Explain to students that "net force" means the sum of all of the forces acting on an object. Also, review the concept of acceleration by asking students to explain their understanding of it, following up with a correct definition, preferably as expressed by a student.

- When students are finished with the video segments, have them add a third column to their charts. For each force they listed in their chart, students should create a diagram of a situation where that force is at work. Their picture should include an indication of where the force acts, and the direction in which the force acts.

- As a class, draw pictures on the board to represent the different forces discussed in the videos.

Virtual Exploration

The purpose of this investigation is to learn what happens when two unequal forces oppose each other.

- Tell students that they will use the Exploration Monster Truck Pull http://app.discoveryeducation.com/player/view/assetGuid/394E92C1-F719-4162-B24B-EC123D15C0B5 to determine what the strongest and closest matches are. Tell students how much time they have to complete this Exploration and worksheet.
- Have students: Read the questions before starting, take notes or record data as necessary and respond to the questions in writing, answer the Comprehension Questions at the end of the passage.

When time is up, ask students to share answers.

Talk about the Discussion Questions at the end of the activity

Differentiation and Support Tips

Struggling students

- Create mixed ability groups.
- Be available to help any students with questions during the Exploration

Accelerating Students

- Challenge students to create a list showing how Newton's Law of Motion applies to other real life applications

Session Fourteen

Hands on Exploration- Pulley Pull

Before beginning this activity, show students how to create a pulley apparatus using a round film canister. Explain that they will be using this apparatus to make predictions about how net force affects the movement of objects with different masses. Divide students into groups of three and have each group construct its own pulley apparatus. Have students draw a force diagram for the objects on the pulley. When students are finished with the force diagrams, they should predict the direction of net force on each object and how it will affect its motion. Have students test their predictions and revise their force diagrams if necessary. Have students summarize their results. Encourage students to share their conclusions with the class. Conduct a class discussion to use this activity to further inform their answers to Lesson Questions.

Explain

In these activities, students will be able to demonstrate their understanding of the main performance expectation (MS-PS2.A) and specific components of the three dimensions of learning that have been incorporated into the sessions. They do this by presenting the evidence they collected along the way, making claims based on that evidence, and finally developing and presenting scientific explanations in response to the Lesson Questions. In some cases, students might have developed their own question(s) to answer. (Disciplinary Core Idea PS2.A; Crosscutting Concept: Stability and Change; Science and Engineering Practices: Scientific Knowledge is Based on Empirical Evidence; Obtaining, Evaluating, and Communicating Information; CCSS WHST.6-8.1, RST.6-8.1, RST.6-8.2).

- Have students use the evidence that they collected in the Explore sessions to complete the Scientific Explanation Student Sheet (sections "Claim" and "Explanation"). Scientific Explanation Middle. Have groups of 2-4 students share their explanation with each other and then revise or enhance their explanations based on group discussion. Bring the class together and have individual students summarize what they now know about force and mass interact that they didn't know before, or have confirmed what they previously knew about these topics. Use these summaries to develop a class consensus on the answers to the Lesson Questions.

Teacher Notes: As students' progress through the lesson, remind them to cite the specific textual evidence that supports the answers to the Lesson Questions. Remind students that a full scientific explanation is not only a claim (answer to the question) but also the evidence to support the claim.

Revisit students' written thoughts from the Engage section. On the board, write down ideas students had before they completed the Explore section of this lesson. Then, students should summarize what they now know about net force that they didn't know before.

Session Fifteen

District Common Lab "Applying Newton's Laws To Collisions"
https://google.discoveryeducation.com/player/view/assetGuid/199be260-03a4-41ba-ae1c-4b15e5ab9fdc

In advance of the lesson, prepare one marble track for each group. To make a track, lay two meter sticks side by side lengthwise and leave a small gap (0.5 cm) between them, as shown in the diagram at right. Tape the tops of the meter sticks together in this arrangement Flip the taped pair over so that the tape is now on the floor. Test the track to be sure that a marble will roll freely along the ridge between the two meter sticks.

To introduce the activity, review the concepts of balanced and unbalanced forces and their effect on the motion of objects. (Students should understand that balanced forces acting on an object would not change the object's speed and direction. This can mean either that the object moves at a constant speed and direction, or that the object remains still. Students should be able to describe unbalanced forces as forces acting upon an object such that the object's speed and/or direction change. Students should understand that a change in speed could mean speeding up or slowing down or starting motion after being stopped.)

Next, show students the experimental setup that they will use for this activity. The setup consists of a marble track lying flat on a flat surface and a cardboard paper towel tube held at an angle to form a ramp. Demonstrate how you can release one marble at the top of the tube at a slight angle so that it rolls down the tube and collides with a second marble sitting at the start of the track. The collision causes the second marble to roll along the track while the first marble bounces back. Ask students what forces were involved in the collision they just observed. Using diagrams on the board, help students understand that unbalanced forces caused the first marble to change direction and the second marble to suddenly begin moving along the track, away from the point of collision. Ask students if they know Newton's third law of motion. Discuss their responses and then repeat the demonstration. Ask students to apply Newton's third law to your demonstration.

Session Sixteen

Common Lab -"Marble Madness"

Stem Project and Hands-On Activity (Students use straws to blow on a marble and create balanced and unbalanced forces. This will allow them to conceptually create and conduct an investigation to meet MS-PS2-2)
https://google.discoveryeducation.com/learn/techbook/units/aca7980d-a6c7-475d-9d82-87d45a377a7e/concepts/46b1fc10-8fdc-4e55-a6b6-14b34ae5cb71/tabs/054d49d8-d8f5-4203-b276-19e25b56cc5f/pages/1D364442-DB44-4D0B-A6B7-326A31011183

To introduce the lesson, review the concepts of balanced and unbalanced forces. Lead students to describe balanced forces as forces acting on an object such that the object's speed and direction do not change. Help students understand that this can mean an object moves at a constant speed and direction, or an object remains still. Lead students to describe unbalanced forces as forces acting upon an object such that the objects speed and/or direction change. Students should understand that a change in speed could be speeding up or slowing down.

https://google.discoveryeducation.com/player/view/assetGuid/09be0502-3b9b-4016-b0f1-92a55b7362ba
In advance of the lesson, prepare one marble track for each group. (Directions in Teacher's Guide). To introduce the activity, review the concepts of balanced and unbalanced forces and their effect on the motion of objects. Next, show students the experimental setup that they will use for this activity. Demonstrate how you can release one marble at the top of the tube at a slight angle so that it rolls down the tube and collides with a second marble sitting at the start of the track. Ask students what forces were involved in the collision they just observed. Using diagrams on the board, help students understand that unbalanced forces caused the first marble to change direction and the second marble to suddenly begin moving along the track, away from the point of collision. Ask students if they know Newton's third law of motion. Discuss their responses and then repeat the demonstration. Ask students to apply Newton's third law to your demonstration. After this demonstration and discussion, have students design two investigations as described in the Teacher's Guide. Place students in groups of three and ask each group to develop a procedure and to propose possible data tables for collecting data. Discuss and approve each group's plan before they begin work. Ask students to make some predictions about expected outcomes before they begin their investigations. At the end of the activity, discuss the group answers to the analysis and conclusion questions with the class.

Explain

In this activity, students will be able to demonstrate their understanding of the main performance expectation (MS-PS2.A) and specific components of the three dimensions of learning that have been incorporated into the sessions. They do this by presenting the evidence they collected along the way, making claims based on that evidence, and finally developing and presenting scientific explanations in response to the Lesson Questions. In some cases, students might have developed their own question(s) to answer. (Disciplinary Core Idea PS2.A; Crosscutting Concept: Stability and Change; Science and Engineering Practices: Scientific Knowledge is Based on Empirical Evidence; Obtaining, Evaluating, and Communicating Information; CCSS WHST.6-8.1, RST.6-8.1, RST.6-8.2).

1. Have students use the evidence that they collected in the Explore sessions to complete the Scientific Explanation Student Sheet (sections "Claim" and "Explanation").
2. Have groups of 2-4 students share their explanation with each other and then revise or enhance their explanations based on group discussion.
3. Bring the class together and have individual students summarize what they now know about force and mass interact that they didn't know before, or have confirmed what they previously knew about these topics.
4. Use these summaries to develop a class consensus on the answers to the Lesson Questions.

- What happens when two unbalanced forces act on an object?
- What kinds of forces can act on an object?

Teacher Notes:

As they progress through the lesson, remind students to cite the specific textual evidence that supports the answers to the Lesson Questions. Remind students that a full scientific explanation is not only a claim (answer to the question) but also the evidence to support the claim.

Revisit students' written thoughts from the Engage section. On the board, write down ideas students had before they completed the Explore section of this lesson. Then, students should summarize what they now know about net force that they didn't know before.

Elaborate

Have students read the reading passage. Alligator Bites with Force Then, arrange students into groups of three to create a force diagram of the narrator sitting on the alligator or a force diagram showing the forces at various positions in a biting alligator's mouth. Encourage students to share their force diagrams with the class.

Project Ideas:

To help your students apply their understanding of forces and their effects, you may wish to have your students complete some or all of the following projects. The time required to complete each project will vary; some may require students to work outside the

Optional Project #1

Have students use **Board Builder** tool to complete one of the following projects: Have students create a presentation about the electrical force and how it functions in our everyday lives. Have students depict the net force on a baseball as it travels from a pitcher's hand to the batter's swing. Encourage students to use video to enhance this project.

Have students create a board with a force diagram and explanation of forces acting on a car while it is braking. Using digital pictures and video could be encouraged for this project.

Optional Project #2 Isaac Newton

Have students research how Isaac Newton developed his Laws of Motion during London's bubonic plague. Students should write a story line, perform a play and record a video explaining how Newton's reason for leaving London led to the development of his three Laws of Motion. Explain each Law and give a modern day application of that Law. Optional: Students could write and draw the information on papers and record a student explaining the papers to create a video.

At the end of day fifteen have students revisit their explanation(model) and adjust, modify, add to it.

Session Seventeen

Evaluate

Constructed Response (20 minutes)

- Have students complete the Constructed Response. Interaction Between Force and Mass (balanced and unbalanced forces)

Differentiation and Support Tips

- Use Spanish Version if applicable.
- After students complete the Brief Constructed Response **Interaction Between Force and Mass**, students can work with a partner to review each other's responses. Student pairs should check the accuracy of each answer by finding the relevant support in the Techbook.

Struggling Students

Encourage students to recall information they put in their Scientific Explanations. Guide them to see how that information relates to the BCR question.

Acceleration

Challenge students to expand their answers to the BCR questions to also explain how drag influences cars or birds in motion.

Critiquing the Myth Busters (25 Minutes)

In order to evaluate students' understanding of science investigation, have them review the video, MythBusters: Forces and Motion: Toy Car vs. Real Car. Provide them with a copy of the student observation sheet and the critique sheet so they can critique how well the Mythbusters conduct a science investigation. Use their results to monitor how well they are grasping the basic steps of science investigation.

Elaborate /Evaluate

Sessions Eighteen - Twenty- Six

In this **STEM project**, students complete a summative assessment by applying what they've learned about Force and Motion.

"Egg Drop Lab" (An engineering activity, student can use this to build background knowledge for their solution, or the teacher can modify this to be the anchoring event. Connects to Engineering Standards and MS-PS2-1)
https://stem.neu.edu/programs/ayp/fieldtrips/activities/eggdrop/

Scientific Model Explanation/Elaboration of Straight Line Motion

To meet the expectation of MS-PS2-1 and the Engineering standards students need to design, test, and refine a device that will protect an object, such as a person, in a collision. The egg drop lab can act as a modeling activity for such a task, where students create prototypes to test their ideas on, and then create a potential solution using realistic technology. They may not be able to actually create this final design, for example if they are creating something to protect a planetary lander headed to Mars. To set the stage for the final explanation a teacher may want to use the STEM in Action page and discuss the careers of aeronautical and transportation engineers. https://google.discoveryeducation.com/learn/techbook/units/aca7980d-a6c7-475d-9d82-87d45a377a7e/concepts/46b1fc10-8fdc-4e55-a6b6-14b34ae5cb71/tabs/054d49d8-d8f5-4203-b276-19e25b56cc5f

Students need to create a design to minimize forces during a collision. This could be designing a helmet for a sport, safety equipment for a vehicle, or something to minimize the impact for a lander on the moon or another planet. Or some other example.

The teacher could use the video "Flight Attendant Free Fall" to introduce the event of a flight attendant who survived a fall from 10,000 meters. One potential task would be for the students to design safety equipment that could help a person survive a similar fall. They need to design a solution and test it. The teacher could have the students use an egg in place of a person, and students would need to find a way to protect the egg within limitations for weight, space, cost, and other factors

as established by the teacher. They should explain their design and create a justification as to why their design is better than others.
"Flight Attendant Free Fall"
https://google.discoveryeducation.com/player/view/assetGuid/01450444-30c9-41f1-b915-1be3c0d715a5

Common Labs

Applying Newton's Third Law to Collisions
Marble Madness

Materials:

Applying Newton's Third Law to Collisions
Per Group:

- marbles, varying sizes, 4
- paper towel tube
- meter sticks, 2
- ruler
- tape, masking

Per Student:

- safety goggles
- science notebook

Marble Madness
Per Group:

- Marble
- 4 hardback textbooks

Per Student:

- Drinking straw
- Safety goggles
- Science notebook

21st Century Teaching and Student Strategies

- Project Based Learning.

- Ownership and Engagement.
- Collaborative Teaching and Cooperative Learning.
- Citizenship, Leadership, and Personal Responsibility. ...
- Mastery of Curriculum and Higher Order Thinking Skills. ...
- Technology and 21st Century Skills.

Special Ed. and ELL Strategies and Resources

Special Education

In the Techbook, complex content is presented using supportive hyperlinks to definitions of key vocabulary and concepts. The Interactive Glossary provides a multimodal, scaffolded experience that enables students with a variety of learning styles/strengths to access grade level content. An inquiry approach using the 5E instructional model (Engage, Explore, Explain, Elaborate, and Evaluate) is an important tool for helping students to understand the scientific process and develop critical thinking skills. In many cases, the skills needed for successful inquiry will require additional support for students with learning disabilities.

Strategies or Tips

- Utilize Assignment Builder to provide a directed inquiry approach for specific students in which they are provided with a detailed procedure or specific set of questions to answer as they proceed to exploration.
- Provide graphic organizers such as spider maps, tables, or cause–and effect charts as appropriate to guide students in note-taking as they explore resources. Model for students how to take notes while watching a video or working through a reading passage. Show students how they can stop, start, and repeat a video clip so they can view materials as many times as necessary or stop to take notes. Allow students to explore the different buttons and links in an interactive or Virtual Lab for several minutes before actually starting the activity. Set a stopwatch or timer and tell students they have x minutes to click through the activity before they actually begin.
- Provide a Main Ideas and Details graphic organizer for students to use to summarize all of their notes. Model for students how to find the overall main ideas by looking for concepts that repeat in their notes (i.e., concepts covered in multiple resources). Take full advantage of the online medium by allowing students to rewatch videos, re-read passages, or redo activities multiple times. The variety of multimodal Discovery Education resources available makes it possible for students who learn differently to approach the content in the ways they learn best. Provide sentence starters and frames to support students in describing what they learned.
- Add linking questions to student worksheets to fill in more tightly any potential logic gaps. Linking questions should

lead students through each thought process required, tying one idea directly to another. Allow students to choose from the various project ideas in order to better suit their learning styles.

- Allow students to type reports or answers to questions rather than writing them out. Allow students to use sketches and diagrams to explain their thinking. Allow students to collaborate with peers on Brief Constructed Responses (BCRs), either discussing their ideas beforehand or writing responses in pairs or small groups. Provide sentence starters, sentence frames, and word banks to support students in demonstrating what they have learned.

ELL's

General Strategies for Supporting ELLs in the Classroom Given the ever-increasing number of English Language Learners in general education, it is in the best interest of school personnel to be aware of ways to support and help students at any English acquisition level. Self-contained classroom teachers as well as content teachers can use these tips to engage and invest ELLs.

- - Do not assume background knowledge or experience.
- - Do not assume accessibility to resources outside of school.
- - Be aware of and respectful of cultural behaviors and restrictions.
- - Teach vocabulary through direct instruction.
- - Connect vocabulary to the curriculum.
- - Provide context-based experiences.
- - Access students' prior knowledge, allowing use of L1.
- - Tie curriculum to students' life experiences.
- - Tie new objectives to past lessons, allowing use of L1.
- - Engage in conversational as well as instructional language.
- - Integrate reading and writing early on.
- - Model correct language.
- - Expand student responses.
- - Use multicultural materials.
- - Identify objectives appropriate to each student's current knowledge base.
- - Familiarize students with the writing process.

For Beginners:

- Use visual aids, especially the "real thing" (realia).
- Model the process and outcome.

- Enunciate clearly; speak slowly in short sentences, in the active voice (not “The trees were consumed by the fire that raged through the forest,” but “The fire burned down all the trees.”)
- Repeat and restate. Use facial expressions and body language.
- Allow students to demonstrate learning non-verbally.
- Front-load, post/provide, and demonstrate key vocabulary.
- Avoid idioms, colloquialisms, word play, jokes, and words with multiple meanings.
- Ask questions with single word answers, and repeat the answers in short sentences.
- Use cloze exercises.
- Pair students with English speaking partners.
- Reduce workload, especially research and home-based projects.

Intermediates:

- Use visuals (photos, objects).
- Model procedures and products.
- Frontload and reinforce content vocabulary.
- Maintain a posted list of specific science vocabulary.
- Give clear, explicit directions in short sentences.
- Provide assignments commensurate with ELL productive language skills.
- Offer students answer choices and/or provide verbal cueing – say the sentence frame(s) for the answer(s) or start the answer sentence. For example, “What is at the center of an atom? Is it a proton or a nucleus?” or “What is at the center of an atom?
- The center of an atom….” Allow reduced workload/output, extra time, and/or differentiated product.

Allow English-speaking partners as needed. Provide multisensory input with closed captions and audio text, as in the Techbook.