Protect Your Cell Phone: Forces and Motion

DEVELOPER: Mi-STAR

GRADE: 6 | **DATE OF REVIEW:** January 2021

Educators Evaluating Quality Instructional Products

"Protect Your Cell Phone": Forces and Motion

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E/I

TOTAL SCORE: 6

CATEGORY I: NGSS 3D Design Score	CATEGORY II: NGSS Instructional Supports Score	CATEGORY III: Monitoring NGSS Student Progress Score
2	2	2

Click here to see the scoring guidelines.

This review was conducted by the Science Peer Review Panel using the EQuIP Rubric for Science.

CATEGORY I CRITERIA RATINGS			CATEGORY II CRITERIA RATINGS			CATEGORY III CRITERIA RATINGS		
A.	Explaining Phenomena/ Designing Solutions	Adequate	**A.**	Relevance and Authenticity	Adequate	**A.**	Monitoring 3D Student Performances	Adequate
B.	Three Dimensions	Adequate	**B.**	Student Ideas	Adequate	**B.**	Formative	Adequate
C.	Integrating the Three Dimensions	Adequate	**C.**	Building Progressions	Adequate	**C.**	Scoring Guidance	Adequate
D.	Unit Coherence	Extensive	**D.**	Scientific Accuracy	Adequate	**D.**	Unbiased Tasks/Items	Adequate
E.	Multiple Science Domains	Adequate	**E.**	Differentiated Instruction	Adequate	**E.**	Coherence Assessment System	Adequate
F.	Math and ELA	Adequate	**F.**	Teacher Support for Unit Coherence	Adequate	**F.**	Opportunity to Learn	Adequate
			G.	Scaffolded Differentiation Over Time	Adequate			

"Protect Your Cell Phone": Forces and Motion

EQuIP RUBRIC FOR SCIENCE EVALUATION

Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. The unit is strong in several areas, including the cohesive development of elements of the Forces and Motion DCI and the variation of student tasks that provide multiple opportunities for students to apply their unique interests to meaningful and engaging scenarios. In addition, the structure of the unit material is clear and easy to follow; the consistent formatting and embedded teacher guidance support teachers to engage students in three dimensional sense-making experiences.

During revisions, the reviewers recommend paying close attention to the following areas:

- **Opportunities for students to own and drive their learning.** Materials include general structures such as bubble maps and questioning techniques aimed at eliciting student questions. However, student questions and prior experiences are cultivated early in the unit but it is the teacher who reminds students of their questions, authenticity of the learning experience would increase if students had a more active role in identifying the need to engage in the practices and apply the lens of a CCC in service of sensemaking. Consider making more connections between students' questions and the transition to the next lesson. Rather than giving students the next Lesson Discovery Question (LDQ), consider allowing them to identify (or co-create) the LDQ for the next lesson; this would add to the authenticity of the learning experience and leverage the need for student questions aimed at figuring out the phenomena.
- **CCC element connections and development**. Raising the targeted CCC elements to the same level of focus as SEPs and DCIs in assessments, rubrics, and progressions would help teachers understand the importance of students building capacity to know when and how to apply CCC elements to novel situations.
- **Equity of Student Expression**. Materials include a wide variety of tasks. However, a majority of the tasks requires written responses with limited opportunities to ensure that all students can express and clarify their individual thinking and sense-making using a variety of modalities.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that the criterion was not met.

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

I.D. UNIT COHERENCE

I.E. MULTIPLE SCIENCE DOMAINS

I.F. MATH AND ELA

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.

ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.

iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A. Explaining Phenomena/Designing Solutions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that learning is driven by students making sense of phenomena or designing solutions to a problem because the unit materials focus on students figuring out lesson-level phenomena and a central design challenge. Students regularly return to the unit design challenge as they make connections of their current learning to the unit design challenge. However, although students have opportunities to ask questions about what they still need to know, their questions and prior experiences do not directly drive and motivate sense-making.

The unit supports students in designing a solution to Marcus' cell phone problem. Each lesson then contains an anchoring experience phase that supports students in developing their questions related to the Lesson Discovery Question (LDQ). Each lesson also contains a connection question that helps students see how their learning from the lesson connects back to Marcus' challenge. For example:

- Lesson 1: Students observe a cell phone break after another object is dropped onto it. The lesson guide suggests to: "Listen for what words are being used and the reasoning behind student explanations. These will provide clues about how students are thinking about forces, what causes a force, and how the amount of force can be increased or decreased" (page 8).
- Lesson 1: The Unit Bubble Map procedure provides teachers with facilitation supports to lead students through the process of developing their questions about the Unit Challenge. Students individually develop questions and then work as a group to identify their top three to share with the class and finally create a class Bubble Map. Students individually answer the Bubble Map questions they believe they can answer partially or completely, using prior knowledge. Students revisit the Bubble Map throughout the unit to reflect on questions they can answer and generate more questions (page 15).
- Lesson 3: Students apply their learning from crushing a paper tower to the unit challenge. "Students describe a way to provide crush protection for a cell phone, applying what they

learned in this lesson. Teams add crush protection ideas to the design and create an explanation about how the design is intended to protect the phone" (page 21).

- Lesson 4: The class gets an introduction to the lesson activities from the teacher, who explains to the students, "There are two goals in this lesson. The first goal is to learn how to conduct a scientific investigation. The second goal is to learn how the force applied to an object, the object size, and change in the object's motion are related. These concepts will be assessed in an Embedded Assessment in the Check phase of this lesson and will also be used in the rest of the unit" (page 11). This teacher direction portrays that the teacher is guiding the learning and not the students.
- Lesson 5: After watching a lesson phenomenon video of gymnasts using a mat to cushion their landing, the lesson states, "Students connect their prior knowledge and current thinking to the lesson's key concepts by thinking about" the questions provided in the teacher materials (page 8). However, it is not clear how students will do this, such as whether they record their thoughts in their journal or share the connections they have made in any way.
- Lesson 6: "The teacher reminds students of the Lesson Discovery Questions (LDQ) they identified in the Check Your Progress phase of Lesson 5: How do scientists/engineers design solutions to protect objects from forces?" (page 7). Although students identify new questions they may have and what they still need to learn at the end of Lesson 5, this LDQ for Lesson 6 was provided to the students by the teacher at the end of Lesson 5. The facilitation guide states "Students are introduced to the LDQ for the subsequent lesson: Lesson Discovery Questions for L06: How do scientists/engineers design solutions to protect objects from forces?" (Lesson 5, page 21). Student questions are recorded and connect to the LDQ however, there are not frequent opportunities for student to feel as if they are driving the learning sequence.

The lessons integrate the developing DCIs with the unit's engineering concepts:

- The Unit Challenge is presented as a phenomenon that students observe and ask questions about in Lesson 1. Each subsequent lesson builds the DCI knowledge to help them design a cell phone case to protect the phone. Each lesson includes a Unit Summary that requires students to connect their learning from the current lesson to the Unit Challenge they will design and test at the end of the unit. For example:
    - Lesson 1: As students design their protective case for their paper people, the teacher is asked to "observe student groups and probe students to gauge their prior understanding of criteria, constraints, and scientific knowledge, such as forces or system models, which they are using to define this problem and design a solution" (page 10).
    - Lesson 3: Students design, construct, and test a paper tower that will withstand the weight of as many books as possible. Students observe their towers and those of their peers to model the forces acting on the towers. A Teacher Note includes the focus of this design challenge: "Although building and testing towers will bring out the competitive spirit of students, the main purposes of this phase are to (1) learn how to use a force model showing how two objects interact; (2) learn how applied forces cause changes in objects; and (3) explore stability and change as they consider the actions of forces on an object" (page 10).

Suggestions for Improvement

- Consider reframing the beginning of lessons where teachers list and tell students the goals to instead prompt students to ask the questions based on the anchoring experience they observed and realize they cannot explain fully.
- Consider making a more direct connection between students’ questions and what they will figure out next about the phenomenon/design challenge within the unit sequence, allowing students opportunities to feel like they are driving the sense-making process.
- Consider providing more opportunities for students to share their prior experiences, how those experiences impact their thinking, and the questions they have.

I.B. THREE DIMENSIONS

Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

i. Provides opportunities to *develop and use* specific elements of the SEP(s).
ii. Provides opportunities to *develop and use* specific elements of the DCI(s).
iii. Provides opportunities to *develop and use* specific elements of the CCC(s).

Rating for Criterion I.B. Three Dimensions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because students are engaged with grade-appropriate elements of the SEP, DCI, and CCC elements. However, there is minimal support for students to develop competence with the CCC elements and not all claimed DCI elements are developed at a middle school level.

Science and Engineering Practices (SEPs) **Rating: Extensive**
The reviewers found extensive evidence that students have the opportunity to use or develop the SEPs in this unit because the materials provide grade-appropriate engagement with elements of the SEPs in service of making sense of the phenomena and designing a protective cell phone case. Student supports are also provided to develop competence in specific SEP elements. However, there are opportunities to increase the time that students engage and develop proficiency in the grade-level portions of the

elements.

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.*
    - Lesson 1: “Students are introduced to the Unit Challenge Scenario and begin to brainstorm about the challenge, specifically about identifying the problem and the criteria and constraints” (page 11).
    - Lesson 7: Students prepare to design and test their cell phone case and complete the Connect Student Problem Statement handout; this includes providing a problem statement and listing the criteria and constraints.

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.*
    - The unit materials provide information along the way as to how student engagement in this SEP will develop over time: “Teacher Note: students will progressively advance their understanding of the SEP “Planning and Carrying Out Investigations” throughout the unit, starting with review and support of Grade 3–5 level elements: plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Lesson activities will help students progress through the Grade 6–8 level elements: plan the investigation individually, identify independent and dependent variables, and determine the tools that are needed and how to record measurements.” (page 13).
    - Lesson 1: Regarding Planning and Carrying Out Investigations, unit materials state: “This SEP is introduced at the grade 3–5 level in this lesson. Students will progress to the SEP at the grade 6–8 level beginning in lesson 4. Within the unit, students work individually, in small groups, and in Unit Challenge Teams to develop and refine multiple investigations” (page 2).
    - Lesson 3: Teacher Note provides a description of how the lessons will transition from the 3–5 element to the 6–8 element: “Teacher Note: Students are making the transition from considering a "fair test" (Grades 3–5 NGSS Standards) to Lesson 4 where they will learn about the components of a "scientific investigation" (Grades 6–8 NGSS Standards) (page 2).
    - Lesson 4: Students use the 6.4_L04_Uncover_Student_PennyLaunchGuide (pages 1–2) to help PLAN investigation #1. The teacher facilitates this process by leading the class through the Student Guide and using prompted questions to facilitate the guide (page 11). In their groups, students use the 6.4_L04_Uncover_Student_PennyLaunchGuide (pages 3–4) to complete investigation #2 with little or no facilitation from the teacher. The teacher provides less help as appropriate depending on class experience and

abilities and directs students to make their own inputs (page 14). Finally, "students complete 6.4_L04_ UncoverAnalysis_StudentGuide to design additional penny launch investigations and predict outcomes based on their experiences in the Uncover Your Ideas activity" (page 14). Reteaching support is provided for students who struggle with the analysis guide.

- Lesson 5: Students work with their group for their Egg Drop Investigation, identifying variables, meeting a portion of the SEP element: *identify independent and dependent variables and controls*. However, students do not develop the remainder of the element as students are provided a data table, amount of data needed, and units for measurements.
- Lesson 5: Students complete the Check Student Ninja Guide and must determine which variables, types of data, etc., therefore transferring their knowledge to a new situation (page 21).

Constructing Explanations and Designing Solutions

- *Apply scientific ideas or principles to design, construct, and/or test a design of an object, ~~tool, process, or system.~~*
    - Lesson 3: Students design, construct, and test a paper tower in order to withstand the force of as many books as possible. "As you are building and doing your preliminary testing, consider the forces that are acting on the towers and how you can use that information to improve your tower design" (page 10). Students develop a force model as an explanation of the forces involved and compare the difference of those towers that had great success and those that did not.
    - Lesson 3: Students are told "You want to reach an item on the top shelf of a closet, but you aren't tall enough to reach it without standing on something. The following objects are all tall enough for the job and available. You may choose one, or a combination of objects to stand upon to help you reach the item on the shelf: a wicker basket, a foil pan, a cardboard box, a styrofoam cooler, a large/one gallon paint can. Select one (or a combination) of objects to stand on in order to reach the top shelf. Use your knowledge of forces to create a two object model that shows where there would be interacting forces between you and the object(s) that you stand upon" (6.4_L03_Uncover Analysis_StudentGuide, page 1).
    - Lesson 6: Students begin to design the protective case for the Unit Challenge. They are presented with criteria and constraints for their designs and begin recording their design ideas on the Unit Challenge Phone Case Design Student Guide. They must identify the components of their design and describe how their cell phone design addresses the Criteria and Constraints.

In addition to the claimed elements, the reviewers found evidence of the students engaged in the SEP **Developing and Using Models**:

- *Develop and/or use a model to predict and/or describe phenomena.*

- Lesson 1: Students observe and model initial ideas of a large object hitting a cell phone. “Students draw a model in their Science notebooks to explain why the old cell phone was crushed, adding labels and text to convey their ideas and to support their explanation.” They then share their model with a partner then with the whole class (page 8).
- Lesson 2: “Students draw an initial model of what they think occurred with forces when they pushed on the wall. Students use a simple diagram to represent the objects (person, wall) and identify forces involved” (page 8).
- Lesson 3: “Students work in small groups (3–4 students) to design and construct a paper tower that will hold at least one textbook for at least 10 seconds.” They then “develop force models as an initial explanation of both the success (tower supports books without moving) and fail (books crushing tower) conditions” (page 11).
- Lesson 7: Students complete One Object Force Analysis Models of the phone case and with the phone inside the case. Students describe what happens when a cell phone is dropped from a specified height with and without a case “Drop Test Force Analysis – Unprotected vs Protected Phone” (L06_Connect_Student_CaseDesign_GraphicOrganizer, page 2).

Disciplinary Core Ideas (DCIs) | **Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the DCIs in this unit. The materials provide grade-appropriate engagement with elements of the DCIs, and there is a reasonable match between two of the elements claimed and evidence of development. However, the claimed ETS element was not developed at the middle school level, and one of the claimed PS2.A elements was not developed or used in the unit.

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).*
    - Lesson 1: Students observe a phenomenon when a larger object falls onto a cell phone. Students begin to model their initial thoughts about what is happening to cause the cell phone to break, they use scientific language as they are able, and also begin to share ideas about how to prevent this from happening. Lesson 1 builds towards this PS2.A element at this early stage in the unit.
    - Lesson 2: “Students construct an explanation to address the lesson question(s) based on the evidence gathered in the Uncover Your Ideas Investigation and information from the Share Your Ideas phase using the ‘Gotta Have Checklist’ as a reference.” The lesson question is “What happens when we push or pull something?” and the sample response provided is “When we push or pull on something we are applying forces. When two objects interact, they exert forces on each other. To model this interaction, we draw forces as vectors that represent the magnitude and direction of a push or pull between objects. We put a red dot at the contact between them. From the dot, we draw equal (in

length) and opposite (in direction) vectors to represent the force pairs that are always present in the interaction" (Unit Summary Table, page 1). Lesson 4: A consensus discussion is facilitated with guiding questions regarding force and motion after students have described the connection to their penny launcher (page 17). Students then take their understanding to the relationships between forces and motion in general.

- Lesson 7: "After completing the crush and drop tests, students complete force analysis models for each test: one to show the force(s) acting on the phone case, and the other to show the force(s) acting on the phone inside the case" (page 8).
- Compiled "Gotta Have Checklist" lists each lesson (1–7), the lesson questions and a list to "Be sure that your explanation includes the following." For example, "L2: Go Push a Wall" Lesson Question "What happens when we push or pull on something?" Gotta Have Checklist "How forces can be represented by vectors, which show direction and magnitude. How forces between two interacting objects occur in equal and opposite pairs. How interacting objects and force pairs can be represented in a model" (Compiled Gotta Have Checklist).

- *The motion of an object is determined by the sum of forces acting on it; if the total force on the object is not zero, the 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.*
  - Lesson 3: Students design and test paper towers that can hold as many books as possible in order to examine "changes in the tower + book system components" (Paper Tower Testing Student Guide, page 1).
  - Lesson 3: "Teacher Note**:** students are not expected to be able correctly model this new situation (i.e., students will likely try to use a Two Object Model, which cannot show why the tower is crushed). Let students experiment with their current understanding of force pairs to address this new situation of forces causing an object to move. In the Share phase, they will have the opportunity to recognize their model shortcomings, see the relationship between the Two Object Model and the One Object Model, and revise their model explanations using a One Object Model" (page 12).
  - Lesson 5: Students test different materials to see which is most effective at cushioning an egg dropped from different heights. Students perform the drops, collect the data, and analyze the results. Students discover that the different landing materials change the way the force is applied to the egg. Guiding questions are provided for a discussion about force and motion: "What happened when the egg landed on an effective material? Use ideas about force to explain how you know. How did an effective landing material affect the collision forces on the egg?" (page 18).
  - Lesson 6: Students view a crash test between a van and a car and discuss if the effects of the collision forces are equal between the car and the van. They then complete the Crash Guide analysis, which includes a One Object Force Model from the perspective of one of the objects involved in the crash. Students also examine the differences in shipping hollow or solid chocolate bunnies and must use their knowledge gained in

previous activities and lessons and apply it to this new scenario: “Use the model and your knowledge of collision forces to describe why the solid chocolate bunnies are more likely to be damaged during shipping. Think about how you could use your understanding of collisions forces to better protect the bunnies from breaking during shipping” (Check Your Progress, page 2). Students then design a solution to better protect the solid bunny.

- Lesson 7: Students complete One Object Force Analysis Models of the phone case and with the phone inside the case. They must include their results of their crush and drop tests of their phone case design and describe the force analysis.

- *All positions of objects and the directions of forces and motions must be described in an arbitrarily chose reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.*
    - This element was cited in the Protect the Cell Phone Unit Information and Materials document (page 2); however, it is not claimed or evident in any of the lessons.

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.*
    - Constraints (must-haves) are provided by the teacher in Lesson 1 paper people challenge. Criteria (would like to have) include using less tape in order to remove it faster and to not damage the paper people (pages 10 and 11).
    - Lesson 1 Paper people: “Students observe the crush tests, make observations of what worked and didn’t work with the designs, and identify how specific parts of a design contributed to the design’s success or failure” (page 12).
    - Lesson 1: “In Unit Challenge Teams, students review the Unit Challenge and identify the problem(s) they are being asked to address, and identify the criteria and constraints of the challenge. They record their thoughts on 6.4_L1_Connect_Student_ProblemStatement” (page 14).
    - Lesson 3” Paper Tower – Criteria and constraints of the challenge are provided by the teacher and it is not clear that students have an understanding that the more well-defined these criteria and constraints are, the more likely their design will be successful.
    - Lesson 6: Students begin to design the protective case for the Unit Challenge. They are presented with criteria and constraints for their designs and begin recording their design ideas on the Unit Challenge Phone Case Design Student Guide. They must identify the components of their design and describe how their cell phone design addresses the criteria and constraints. Although students must address the criteria and constraints in their phone case designs, there is no explicit activity that asks students to include the relevant scientific principles and knowledge and how these may limit the possible design solutions.

Crosscutting Concepts (CCCs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the CCCs in this unit because there are sufficient CCC elements that students are engaged in for the scope of the unit. Several of the lessons include elements previously developed from the lower grade band. However, it is not clear in the lessons how students will use the CCCs and if they are aware that they are using them.

System and System Models

- *Models can be used to represent systems and their interactions – such as ~~inputs~~, processes, ~~and outputs~~ and energy, matter, and information flows within systems.*
    - Lesson 1: Students are reminded of the semester Unifying Crosscutting Concept: Systems and System Models. Students have a short whole-class discussion about how the Unifying CCC connects with the Unit Challenge Questions. A callout box with teacher notes to scaffold questions from 3–5 grade level proficiency to 6–8 level (pages 13–14).
    - Lesson 2: As students work to create a group model to explain what is happening when they push on a wall, they work to come to consensus on how to represent different components of the forces model. They discuss how to represent a system using a dashed line to indicate the system boundaries.
    - Lesson 3: “Teacher Note: students are not expected to be able to correctly model this new situation (i.e., students will likely try to use a Two Object Model, which cannot show why the tower is crushed). Let students experiment with their current understanding of force pairs to address this new situation of forces causing an object to move. In the Share phase, they will have the opportunity to recognize their model shortcomings, see the relationship between the Two Object Model and the One Object Model, and revise their model explanations using a One Object Model” (page 11).

Stability and Change

- *Explanations of stability and change in natural and designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
    - Lesson 3: Students work through each paper towel model as a class using guiding questions that are provided. Example Guiding Questions: “What causes the stability of the tower to change as more books are added?” and “Is 1 book on the tower stable or unstable? How do you know?” (page 16). The teacher guidance states that students should identify the Two Object Model as stable. Students also view the stability of the paper tower with a One Object Model to show the forces acting upon the paper tower alone. However, it is not clear that students are applying this particular middle school-level element in order to make sense of the paper towers and force models. They seem to instead use this Grade 3-5 element: *Change is measured in terms of differences over time and may occur at different rates.*

- Lesson 6: Students observe a crash test between a car and a van and model the changes that take place when forces are unbalanced. Although students answer questions about what changes in motion occur, it is not clear that students are aware they are applying this middle school-level element in order to make sense of the crash test and force models. They seem to instead use this Grade 3-5 element: *Change is measured in terms of differences over time and may occur at different rates.*
- Lesson 7: The Lesson Introduction describes what students will do by the end of this lesson: "They explain that when forces on the phone are balanced, the phone is stable (i.e. not changing its motion); when forces are unbalanced, it changes its motion (or shape); when the phone changes speed rapidly, such as on hitting the floor, it can break. Students explain that phone protection engineering aims to reduce the magnitudes of forces acting on the phone: increasing the collision time (decreasing the change in motion) and increasing the area over which the forces are applied to the phone (page 4). However, it is not clear that students are applying this middle school-level element in order to design a solution to the Unit Challenge. They seem to instead use this Grade 3-5 element: *Change is measured in terms of differences over time and may occur at different rates.*

Suggestions for Improvement

General

- Although the unit focuses on developing elements of the three dimensions that are found in the targeted PEs, coherent NGSS- and Framework-based instruction asks students to apply a large range of SEPs and CCCs. It would be consistent with the NGSS and the vision of the Framework to call out previously-developed elements that are used, even though they are not targets of development in the unit. This kind of transparency would be helpful to teachers to know when students are asked to apply SEPs and CCCs that were developed in previous units, because some students might not have had those prior experiences and would need extra supports in those areas. For example, this unit requires students to use a Developing and Using Models element, and some students might not have had opportunities to previously develop it. Explicitly naming this element as required prior learning would therefore be very helpful.

Science and Engineering Practices

- Consider providing more opportunities for the students to plan their own investigations and develop their own methods for collecting and recording data.
- Consider developing all parts of the **Asking Questions and Defining Problems** element: *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* as the unit progresses. There were opportunities to support student use of this element that are not currently taken advantage of.

Disciplinary Core Ideas

- Consider including more discussion or activities focusing on the **ETS1.A** element identified in the unit to allow students to understand *how identifying the criteria and constraints help their design be more successful.*
- Consider removing the element *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.* from Protect the Cell Phone Unit Information and Materials document (page 2). This would allow a closer match between the claims and the evidence of student use in the materials.

Crosscutting Concepts

- Consider making CCC use clear to students so they are aware they are using them and why understanding and applying the elements of the identified CCCs are helpful in making sense of phenomena and in designing solutions to problems.
- Consider supporting students to use and understand all aspects of the **Systems and System Models** element – including inputs and outputs of systems.
- Consider supporting students to build on their Grade 3–5-level understanding of Stability and Change, moving toward an understanding of middle school-level elements, such as the one claimed. This could include discussion of change processes at different scales or switching the claimed element to focus more on the difference between sudden changes and gradual changes over time.

I.C. INTEGRATING THE THREE DIMENSIONS

Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena or designing solutions to problems because there is at least one significant activity where students are expected to figure something out or solve a design problem in a way that requires grade-appropriate elements of each of the three dimensions working together. In some student performances in the unit, it is not clear if a grade-appropriate CCC element is required or used in completing the activity, but in many of those cases students are supported to use a grade-appropriate two-dimensional performance for sense-making or problem solving.

Related evidence includes:

- Lesson 5: Students test the cushioning effect of three different materials when an egg is dropped onto them. Students select the materials to test and use the Uncover Your Ideas Investigation Guide to complete their investigation. Students must identify the independent, dependent variables, and the constants. Students complete five trials from different heights. Students make a claim about which material is most effective at protecting the egg and “describe your evidence and reasoning to support your claim for which landing material is best” (page 3) They then analyze the One Object Force Model and add the vector to the model for Test 2. Following the investigation, students discuss the Guiding Questions, such as “What do we know about stability and change in motion of the object?” and “In which of the situations are the forces balanced? How do you know?” (page 11). (Planning and Carrying Out Investigations, PS2.A, and Stability and Change) However, this performance uses a 3–5-level CCC element and not a grade-appropriate element.
- Lesson 7: “Students build, then test their cell phone case using their planned investigations for the crush test and the drop test.” (SEP: Planning and Carrying Out Investigations) “Students analyze strengths and weaknesses of their case design, evaluate the case using criteria and constraints, and update their model with the observed forces” (DCI: Forces and Motion) before constructing a poster to display their challenge results.” “In their final posters, students make an argument for whether their phone case is a good solution, based on whether it met constraints, and based on how well it satisfied Marcus’s desired criteria. Students support their argument with system models that explain the forces acting on the mock phone during the tests” (CCC: Systems and System Models) (pages 4–6).

Suggestions for Improvement

Consider highlighting the targeted Crosscutting Concepts in a more explicit way to ensure that a grade-appropriate element of the CCC is addressed and that students are aware that they are using them and why they are important in helping students make sense of phenomena. For example, analysis activities and the design challenge could be set up in a way that requires students’ explicit use of a targeted CCC element in order to successfully complete the activity.

I.D. UNIT COHERENCE

Lessons fit together to target a set of performance expectations.

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.

ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

Rating for Criterion I.D. Unit Coherence	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that lessons work together and each lesson builds directly on the previous lesson. Strategies are embedded to make the links explicit from the student perspective. Students also have opportunities to build toward all the identified three-dimensional learning goals. Related evidence includes:

- A Unit Bubble Map is created and revisited throughout the unit. For example:
  - Lesson 1: "Students compile a list of smaller questions they must answer in order to get at the Unit Challenge Question. This can be achieved using a 'Unit Bubble Map' procedure outlined below" (page 15).
  - Lessons 2 and 3: "Students reflect on the Class Unit Bubble Map, and update it with new answers and questions. This may be done individually, in groups, or as a class activity. Which Unit Bubble Map questions have you answered? What do you still need to learn?" (pages 19 and 24).
  - Lesson 6: "In the Check Your Progress phase of Lesson 5, you helped students group their questions from the Unit Bubble Map into a Lesson Discovery Question to drive this subsequent lesson. If you wish, you can show the Unit Bubble Map questions again here to let students see the connections between their questions and this Lesson Discovery Question" (page 7).
  - Lesson 7: "As a whole group, students review the Unit Challenge Scenario and the class Unit Bubble Map, and discuss and reflect on what they have learned and what they still need to figure out" (page 6).
- Lesson Discovery Questions (LDQs) accompany each lesson. However, there are missed opportunities for students to make explicit connections between lessons. For example:
  - Lesson 2: "After each revision of the Unit Bubble Map, student questions need to be organized and consolidated into a Lesson Discovery Question for the subsequent lesson. Although student questions are inspired from the Unit Challenge Scenario, they may or may not be relevant to the Unit Challenge. Assist students to see their most relevant

topics leading to the upcoming Lesson Discovery Questions and/or the Connection Questions, so that they observe their work "driving" the lesson (page 19).
  - In subsequent lessons, the support provided to teachers just states to introduce the LDQ for the next lessons and ask student to reflect on their questions. For example, Lesson 3: "Students reflect on their questions from the Bubble Map and see the questions to the next lesson" (page 25). Students are given the next lesson question and asked to reflect on their bubble map.
  - Lesson 5: "Lesson Discovery Question: How does cushioning affect what happens when two objects interact?" (page 1).
  - Lesson 6: "The teacher reminds students of the LDQ(s) they identified in the Check Your Progress phase of Lesson 5: How do scientists/engineers design solutions to protest objects from forces?" (page 9).

Suggestions for Improvement

- Consider providing teacher guidance that will help students understand the connections between the themes and content.
- Consider providing specific prompts in each lesson to facilitate student questions for the next lesson and new questions specific to the lessons just completed.

I.E. MULTIPLE SCIENCE DOMAINS

When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

i. Disciplinary core ideas from different disciplines are used together to explain phenomena.

ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that links are made across the science domains when appropriate because the design challenge and lesson-level phenomena driving the learning can be fully addressed within the Physical Science domain. However, crosscutting concepts are not explicitly used to make connections across science domains.

Related evidence includes:

- The unit design challenge focuses on PS2.A Force and Motion and does not require other science domains to fully address the unit objectives.
- Lesson 7: The engineering design task requires application of the physical science domain: "Students analyze strengths and weaknesses of their case design, evaluate the case using criteria and constraints, and update their model with the observed forces before constructing a poster to display their challenge result" (page 6).

Suggestions for Improvement

- Consider finding ways to make connections between the Physical Science concepts to examples from Life or Earth Science, such as ways forces affect Earth's surface.
- To move this rating to Extensive, consider helping students use one or more CCC element in an explicit way to make connections across science domains, such as identifying where a CCC element was used in a prior life science unit. This kind of explicit discussion helps students understand how the CCCs function as unifying ideas across all science domains.

I.F. MATH AND ELA

Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

Rating for Criterion I.F. Math and ELA	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS) in mathematics, English language arts (ELA), history, social studies, or technical standards because materials explicitly call out mathematics and ELA standards and state where they are used in the unit.

Related evidence includes:

- Overview tables are provided in each lesson, listing connections to CCSS ELA-Literacy, CCSS Math and CCSS Literacy in Science and Technical Subjects and which phase of the lesson has the opportunity to support that CCSS connection. However, within that phase of the lesson, reviewers were unable to find connections during facilitation for teachers or students to know how or why they are connecting to that standard.
- Lesson 2: An overview table is provided to show the specific ELA and Mathematics CCSS that will be addressed and in which activities they are present. For example, the Standard for Mathematical Practice MP.2 *Reason abstractly and quantitatively* is identified and the activity that addresses this is listed as: "Reason as to appropriate symbols to show force and force magnitude" (page 3).

- Lesson 2: The overview table includes several activities within Lesson 2 that address the following ELA standard, such as write-pair-share, guiding questions, consensus discussion, and Unit Challenge Team initial model and explanation: ELA.Sl 6.1, 7.1, 8.1 *Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6, 7, 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.*
- Lesson 6: Students view a video of a crash test between a car and a van. Students work in small groups to write a force and motion story from the perspective of one or more objects within the system, giving them the opportunity to use this claimed standard: WHST.6-8.2 *Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.*

Suggestions for Improvement

- Consider including more opportunities for students to use reading skills in various types of materials to develop understanding and explanations of the science concepts. This could include reading news articles, journal articles, narrative stories, infographics, and/or websites of scientific entities.
- Consider providing explicit language from the CCSS standards in the prompts used for teacher guidance and for student responses in activities so they are aware of making connections across the standards.

OVERALL CATEGORY I SCORE: **2**	
Unit Scoring Guide – Category I	
Criteria A-F	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

CATEGORY II

NGSS INSTRUCTIONAL SUPPORTS

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

II.A. RELEVANCE AND AUTHENTICITY

Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).

ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.

iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authenticity	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because students have opportunities to experience phenomena firsthand or as directly as possible. The unit design challenge and lesson-level phenomena are engaging, grade-appropriate, and include scenarios that students should be motivated to figure out or solve. However, there are few opportunities and minimal support for teachers to help students connect the problems they are solving to their own prior experience, community, and/or culture.

Related evidence includes:

- The students experience phenomena firsthand or as directly as possible. For example:
    - Lesson 3: Students view a variety of objects being crushed in a hydraulic press to connect their prior knowledge and understanding to the question "Why do things sometimes get crushed and other times not?" (page 8).
    - Lesson 5: "Gymnastic Bloopers" are used to visually connect to the question "How does cushioning affect what happens when two objects interact?" (page 8).
    - Lesson 6: "The class is broken into small groups, and each group is given a card with an object name of a small, fragile object to protect from forces throughout a typical school day (spaghetti noodle, baby, pumpkin, goldfish, carton of milk, banana, eyeglasses). Teacher Note: feel free to ask students to come up with the fragile items. Items (not the baby!) could be presented as a slide show or the actual items" (page 7).
- The unit includes suggestions about how to connect instruction to students' home, neighborhood, culture as appropriate:
    - Lesson 1: Students observe and model initial ideas of a large object hitting a cell phone. The introductory material includes data on the use of cell phones and notes that 95% of the population owns a cell phone so it is likely students have one.

    - Lesson 5 engages students in an egg drop design challenge but tells the teacher "as enjoyable as breaking an egg can be for a 6th grader, consider asking THEM what delicate object they would like to test by dropping onto different materials. While they may ultimately prefer dropping eggs, giving them a larger role in the design process could help students connect more deeply to the experimental process" (page 10).
    - Lesson 6: Students are asked to contribute ideas of other everyday objects that might need protecting during a typical school day.
- Uncover Your Ideas phase in many of the lessons also provide the opportunity to connect to a real-world phenomenon.
    - Lesson 6: Students are prompted with teacher questions to consider a crash between a car and a van. Then, students watch a crash test video. Teacher questions prompts and sample responses are provided to guide student connections to what they observed in the video (pages 9–12).

<u>Suggestions for Improvement</u>

- In Lesson 6, consider flipping the student step in the anchoring experience so that students are first asked to come up with the fragile items they want to protect during the school day. Then, if students cannot come up with something on their own, the list (spaghetti noodle, baby, etc.) could be provided as a scaffold. This could represent a more authentic opportunity for students to connect to the challenge.
- Consider adding a section after each anchoring experience for students to share any related phenomenon they can think of so they may connect what the anchoring experience may be presenting to their own lives in an authentic manner.

II.B. STUDENT IDEAS	
Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.	
Rating for Criterion II.B. Student Ideas	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas because the teacher is supported as a facilitator to draw out student ideas, provide opportunities for student conversations, and opportunities for students to revise thinking. However, discourse strategies are generalized for the unit and not specifically customized to the lesson materials, and there are few opportunities for students to reflect on and respond to the feedback they receive.

Related evidence includes:

- A supplemental document link is provided in the lessons to support teachers in facilitation of a variety of strategies for best practices in science instruction. The “Mi-STAR Pedagogical Strategies & Tools Catalog” shares a variety of strategies to help students share their ideas and reach consensus. However, the support is not specifically customized to the lesson materials. Lesson 2: Students pair up and discover how it feels when they push on each other’s hands. They are asked to push with different amounts of forces and compare these experiences with pushing on the wall. Students write-pair-share about how it felt to push on the wall and attempt to explain why the wall did not move.
- Lesson 3: Students engage in a class discussion. Teacher guiding questions are provided along with example student answers and supplemental teacher guidance for helping students see where their ideas may need to be built upon. Students are then prompted to revise their initial model to explain why the tower crushed (pages 16–18).
- Lesson 7: “Students work in their Unit Challenge Teams to revise their own posters based on feedback from others. Students consider their ideas through a line of questioning similar to the following: Did the other group agree with your evidence and arguments? Why or why not? Are you missing any information? What did you learn from the poster of another team?” (page 11).

Suggestions for Improvement

- Consider customizing classroom discourse strategies to specific lessons and activity contexts. While there are pedagogical strategies in a separate document, it might be helpful to provide some targeted strategies that address the specific activities within each lesson. In addition, each strategy from the linked document could be represented with a graphic and one or two graphics could be added to the margin recommending the strategy/strategies recommended. This would also prompt teachers to revisit the linked document.
- Consider adding guidance on when teacher feedback should be given and how to frame the feedback to support improvement in performance.

"Protect Your Cell Phone": Forces and Motion

EQuIP RUBRIC FOR SCIENCE EVALUATION

II.C. BUILDING PROGRESSIONS

Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

i. Explicitly identifying prior student learning expected for all three dimensions

ii. Clearly explaining how the prior learning will be built upon.

Rating for Criterion II.C. Building Progressions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions because the unit materials state the expected prior proficiency students have with the core learning in the materials. Lessons include supports for teachers to clarify potential misconceptions. A progression of learning toward the targeted elements of the three dimensions is described for teachers. However, the element-level learning progression description for the CCCs was not explicit and how each section of the materials progresses student proficiency with specific portions of the targeted elements are vague.

Related evidence includes:

- Lessons 2–7 all include a "Lesson Introduction" that reviews learning in the previous lesson and introduces learning in the new lesson. However, this section does not specifically reference the elements of the three dimensions or how the prior lesson elements are being built upon. For example, in Lesson 5: "Previously, students were introduced to the Two Object Force Model (L2) and the One Object Force Model (L3) before exploring the relationship between force, mass, and acceleration (thus far called change in motion). Students have extensively practiced modeling, and have done several investigations on crushing, which is one of the two tests needed for the Unit Challenge. Students still need to explore the 'drop test', which is the other test of the Unit Challenge, as well as more work with collision between objects" (page 5).
- A "Unit 6.4 Prior and Future Knowledge" Chart is linked to Lesson 1. "This document compiles information from the NGSS Framework and Mi-STAE Curriculum to highlight the learning progressions of the DCIs, CCCs, and SEPs of the unit. It separates the progression into grade bands: 3-5, 6-8 (Units 6.1-6.3), 6-8 (Units 6.5-8.7), and 9-12" (6.4_TeacherBackgroundCOntentResources_PUBLIC, page 1).
- The unit materials provide details about how SEP elements progress through the lessons. For example:
    - "Students will progressively advance their understanding of the SEP "Planning and Carrying Out Investigations" throughout the unit, starting with review and support of Grade 3–5 level elements: *plan and conduct an investigation collaboratively to produce*

data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. Lesson activities will help students progress through the Grade 6–8 level elements: *plan the investigation individually, identify independent and dependent variables, and determine the tools that are needed and how to record measurements*” (Lesson 1, page 13).

- Lesson 1: Regarding **Planning and Carrying Out Investigations**, unit materials state: “This SEP is introduced at the grade 3–5 level in this lesson. Students will progress to the SEP at the grade 6–8 level beginning in lesson 4. Within the unit, students work individually, in small groups, and in Unit Challenge Teams to develop and refine multiple investigations” (page 2).
- Lesson 3: Regarding **Planning and Carrying Out Investigations,** “Teacher Note” provides a description of how the lessons will transition from the 3–5 element to the 6–8 element: “Teacher Note: Students are making the transition from considering a "fair test" (Grades 3–5 NGSS Standards) to Lesson 4 where they will learn about the components of a "scientific investigation" (Grades 6–8 NGSS Standards)” (page 25).
- Lesson 4: Students brainstorm in groups to make a fair test to determine the fastest office chair. Guiding questions are provided to address different facets of a fair investigation: “How far?, How many times?, How do we keep track of race information?, How will we know who wins?” (page 9). Students ask questions about what they still need to know about planning a fair investigation, and then conduct a Penny Launch activity to focus on different aspects of a fair investigation. The teacher provides a step-by-step list of the testing procedures. Students must describe what changes and what conditions remain the same and how they can consistently and accurately apply the force. Students answer questions about how to design an investigation using the prompts on the Uncover Analysis Student Guide. Students describe the steps they took to ensure a scientific investigation. “Students use their science journals to develop their initial explanations about investigations into scientific writing by defining and then using Science Words (independent variable, dependent variable, constant, mass, force, change in motion, scientific investigation)” (page 18).
- Lesson 5: Students test the cushioning effect of three different materials when an egg is dropped onto them. Students select the materials to test and use the Uncover Your Ideas Investigation Guide to complete their investigation. Students must identify the independent, dependent variables, and the constants. Students complete five trials from different heights. Students make a claim about which material is most effective at protecting the egg and “describe your evidence and reasoning to support your claim for which landing material is best” (page 3). They then analyze the One Object Force Model and add the vector to the model for Test 2.
- Lesson 7: Students complete a peer evaluation tool based on the phone case design drop test results. They are asked to describe how the dependent variable was measured and explain if the recorded data provide a fair measure of the dependent variable. For the crush test, students must identify both the independent and dependent variables and predict which phone would be damaged based on the force models provided.

- The unit materials provide some details about how the CCC elements develop throughout the lessons however, the progressions are vague. Related evidence includes:
  - Lesson 1: The CCC of **Systems and System Models** is addressed early in the unit at the 3–5 grade band level and later lessons address a 6–8 grade level element. "Students observe the results of their simple test, determine if a design was successful (or not) and define a system and its components to help analyze the design. In the designs that worked, students identify how parts of the system worked together to protect an object from being crushed. In the designs that did not work, they identify which parts of the system failed" (page 5).
  - Lesson 1: The suggested formative assessment during the Unit Challenge is provided to assess student understanding of Systems and System Models: "Assessment: C*CC-Systems and System Models*. Student answers to the guiding questions can be assessed for understanding of systems and system models. Teacher Note: these questions can be used to help guide students towards grade level CCC understanding as they complete the unit. Questions 1 and 2 are at Grade 3–5 level, representing earlier lessons; questions 3 and 4 are at Grade 6–8 level, representing later lessons" (page 13).
- Lesson 7: Students develop force analysis models for two different systems, one for the cell phone case crush test and one for the drop test to show the forces acting on the phone case and the forces acting on the phone inside the case (page 8). Unit materials provide a clear progression of DCI elements, as each part of the learning builds on prior lessons and develops each DCI element more deeply with each lesson. For example:
  - **PS2.A:** Students start modeling forces between two interacting objects in Lesson 2 and progress to the concept of force model systems and change in motion with unbalanced forces in Lesson 3. Lesson 3 "In this lesson, students draw on their experience from L01 (protecting paper people) and L02 (force pair modeling) as they design and build paper towels to support textbooks. Students test each tower until it fails (no longer supports additional books). Students model the forces acting on their towers before and during failure, and realize that force pairs in a Tow Object Model cannot be used to describe or predict tower failure that involves a change in motion. Students are introduced to the One Object Model to visualize the forces acting on a single object and how these forces affect the object's stability and motion" (page 5). Lesson 4 adds on the concept of mass and how different masses can change the force impact. The development of the **PS2.A** element is seen in Lesson 3. "Teacher Note**:** students are not expected to be able correctly model this new situation (i.e., students will likely try to use a Two Object Model, which cannot show why the tower is crushed). Let students experiment with their current understanding of force pairs to address this new situation of forces causing an object to move. In the Share phase, they will have the opportunity to recognize their model shortcomings, see the relationship between the Two Object Model and the One Object Model, and revise their model explanations using a One Object Model" (page 11)
  - **ETS1.A:** Students begin considering the criteria and constraints for the Unit Design Challenge with an introduction to including criteria and constraints in their designs. By the end of the unit students identify the criteria and constraints and evaluate other

students’ designs to see if they have followed the criteria and constraints in their cell phone case design.

- Misconceptions are addressed in several lessons. For example:
    - Lesson 2: The teacher is told “While students may cite pop-culture references (‘air force one” or ‘may this force be with you’), students should be guided to the physical definition of force, which can be stated as follows: Force: a push or pull acting on an object” (page 8).Lesson 5 and 6: “Teacher Note: class discussion of the One Object models may reveal some common misconceptions about force vectors that can be addressed here. For example, students often confuse “force vectors” with “direction of motion arrows” on the One Object models of the egg colliding with the landing surface. Therefore, some group models may incorrectly show force vectors pointing downwards” (Lesson 5, page 14 and Lesson 6, page 14).

Suggestions for Improvement

- Consider supporting teachers to see how students will build on each part of the three dimensions by adding specific elements of each dimension to the lesson introductions and within the lessons and highlighting the portion of the elements in which students are building proficiency.
- In the Lesson 5 Egg Drop activity in which students build understanding of using system models throughout the lesson, consider requiring more direct student involvement in developing the model for test 1 to develop student independence in using the **CCC Systems and System Models.**

II.D. SCIENTIFIC ACCURACY

Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students’ three-dimensional learning.

Rating for Criterion II.D. Scientific Accuracy	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials use scientifically accurate and grade appropriate scientific information because science ideas and representations included in the material are accurate. However, an analogy is used in Lesson 5 that may lead to misconceptions in student understanding of physical forces.

Related evidence includes:

- The Additional Resources to Support Teacher Background Knowledge document is broken up by NGSS sub-components as supports for teachers to develop their understanding in common misconceptions for students. For example, a website on the “big misconception” is provided “Web page on THE big misconception: Forces do not cause motion; forces cause acceleration. Has link to an interactive simulator: ‘Rocket Sledder’” (6.4_TeacherBackgroundContentResources_PUBLIC).
- Lesson 3: “Teacher Note: students are not expected to be able to correctly model this new situation (I.e. students will likely try to use a Two Object Model, which cannot show why the tower is crushed). Let students experiment with their current understanding of force pairs to address this new situation of forces causing an object to move. In the Share phase, they will have the opportunity to recognize their model shortcomings, see the relationship between the Two Object Model and the One Object Model, and revise their model explanations using a One Object Model” (page 11).
- Lesson 4: Reteaching Support “Help the students make the connection that the red ball is similar to the binder clip. We will change the forces (i.e. velocity) of the red ball, but not the mass” (page 14).
- Lesson 5: “Teacher Note: class discussion of the One Object models may reveal some common misconceptions about force vectors that can be addressed here. For example, students often confuse “force vectors” with “direction of motion arrows” on the One Object models of the egg colliding with the landing surface. Therefore, some group models may incorrectly show force vectors pointing downwards” (page 14). Lesson 5: “There are many everyday examples (e.g., mental models) you or your students can use to support understanding of these concepts. For example, you could liken this to flattening of the curve during the COVID pandemic. The amount of damage can be lessened by spreading the number of people needing medical care out over time to prevent additional loss due overwhelming the health care system” (page 15). The reviewers appreciate the thoughtful inclusion of the current impact of COVID cases on the healthcare system, but caution against using this analogy, which could lead to confusion. Reducing the stress/damage/impact on the healthcare system by “spreading the number of people needing medical care out over time” may end up producing a similar graph as cushions spreading impact over time,” but the reasoning behind the data/graphs are not the same. Using the reasoning for the COVID graph (impact on a system) might lead to confusion when applying it to cushions (force on a physical object).
- Lesson 6: A set of slides with a progression of models are available to use with students if they have misconceptions about force vectors.

Suggestions for Improvement

- Consider switching the COVID-related analogy in Lesson 5 to something else that uses similar reasoning to the cushioning example.
- Consider adding explicit guidance for the teacher to address or react to student misconceptions.

II.E. DIFFERENTIATED INSTRUCTION

Provides guidance for teachers to support differentiated instruction by including:

i. Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.

ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction because the materials clarify how they anticipate the needs of students who might struggle and supports are provided for students with varying abilities. In addition, multiple learning modalities are provided to students. However, supports for students with special needs, English language learners and students who read well below grade level are generalized and the same for all lessons, rather than being tailored to the lesson activities.

Suggestions and resources to support struggling students are provided in the unit. Some of the resources support LEP students and there are extension activities for students who are ready for deeper study of the concepts. For example:

- Lesson 2: The Teacher Note section includes guidance on how teachers can scaffold the group modeling activity: “Teachers may use the guiding questions below to scaffold students in creating their consensus model” (page 9). Example guiding questions are provided.
- Lesson 2: Pedagogical Resources are provided for the Share Your Ideas phase of the lesson. Other options are provided for the student consensus model discussion: “For other ideas about how to help students build off of each other’s ideas see Mi-STAR Pedagogical Resources” (page 13).
- Lesson 2: The lesson includes a listing of guidance for additional activities that can be added if students are not acquiring the concepts. For example, “If students are struggling with the analysis questions and concepts of vectors, magnitudes and force pairs, teachers could supplement instruction with the following activities and questions: Phet lab simulation on forces and motion” (page 20).

- Lesson 3: includes reteaching support if students are struggling with the analysis questions. A website and a simulation are provided.
- Lesson 4: “Students struggling with the relationships between force, mass, and motion could explore some of the activities and experiments using balloon rockets found here: https://www.steampoweredfamily.com/activities/physics-activities/. In addition, students could identify the independent, dependent, and control variables in each of the activities and explorations to reinforce the concepts of a fair experiment” (page 24).

Multiple modalities are provided throughout the unit such as modeling, writing a story and a poem, gallery walks to compare student thinking, peer evaluations, and small group discussions. For example:

- Lesson 1: Students create initial models of the unit phenomenon: what happened to the phone when it was broken by a larger object that fell on it. Students are asked to use two modalities, visual and reading/writing when they draw and label models and provide text to support their explanation.
- Lesson 3: “Students watch a video of various household objects being crushed in a hydraulic press to consider how forces can cause change in an object’s motion and/or shape. Students write a four-sentence poem about what they saw in the video and share with student groups” (page 8).

Extension activities are provided for students who already met the performance expectation(s). For example:

- Lesson 4: “L04 Share Resource 4 - (Extension) if student understanding is sufficient to explore a related phenomenon: force modeling (Newton’s Second Law) - predict and model new Penny Launch results” (page 20).
- Lesson 5: “L05 Share Resource 3 -(Extension) if student understanding is sufficient to explore a related phenomenon: observe and analyze a new method of protecting a dropped egg” (page 17).

Suggestions for Improvement

- Consider providing more supports that are varied for LEPs and non-LEP students. Resources to consider include http://udlguidelines.cast.org and http://www.csun.edu/science/ref/language/teaching-ell.html
- Consider adding supports and alternative activities for students with special needs and those who read well below grade level.
- Consider ensuring that supports for all students help them develop in all three dimensions equally.

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

Supports teachers in facilitating coherent student learning experiences over time by:

i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

Rating for Criterion II.F. Teacher Support for Unit Coherence	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials support teachers in facilitating coherent student learning experiences over time because guidance and tools are provided to teachers to support linking student engagement across the lessons. Evidence for most of this criterion is very strong. However, there is not evidence that students feel that what they are learning about using CCCs is relevant to the sense-making.

Related evidence includes:

- A Unit Bubble Map is used to organize student learning and questions that still need to be answered and it is frequently revisited throughout the unit:
  - Lesson 1: At the end of lesson 1, "Students reflect on what they need to know to address the Unit Challenge Question by completing a Unit Bubble Map activity that requires them to brainstorm smaller questions they must answer in order to address the Unit Challenge Question. The goal is to elicit at least three questions that can be mapped to the lesson questions from the unit" (page 14).
  - Lesson 2: Students revisit the questions they generated about the unit phenomenon/challenge: "Students reflect on their questions on the Unit Bubble Map and see the connections between their question(s) and the Lesson Discovery Question for the next lesson" (page 23). They revisit the Unit Bubble Map again at the end of Lesson 3 to make connections and to identify what still needs to be figured out.
  - Lesson 5: "Students reflect on the Class Unit Bubble Map, and update it with new answers and questions. This may be done individually, in groups, or as a class activity. Which Unit Bubble Map questions have you answered? What do you still need to learn? What new questions do you have?" (page 21).
- A Unit Summary Table is used throughout the unit for students to record what they have learned at the end of each lesson. Students include the evidence they have to support their explanations and also complete a Connecting My Ideas to the Unit Challenge section in order to utilize what they have learned to modify their cell phone protector design.

- "Connect Your Ideas (Connection to the Unit Challenge) sections of the unit plan include opportunities for students to connect new learning to the challenge question introduced in Lesson 1. For example, Lesson 2: "Students brainstorm ideas about the forces acting on an unprotected cell phone when it is crushed, then create a sketch showing the forces acting on the phone. The sketch uses the norms for describing forces that students have established in the previous phases, and is used to communicate their ideas to Marcus" (Lesson Plan, page 16).

Suggestions for Improvement

- Consider providing clear guidance to teachers for facilitating discussions with students so they can clearly see how they are building their understanding in all three dimensions in the Lesson Summary Table. One idea may be to highlight in different colors where students may be addressing an SEP, DCI, or CCC component.
- Consider adding strategies to help students see how their uses of and engagement in the CCCs assist them in making progress in their learning of DCI elements and with the unit design challenge.

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

Rating for Criterion II.G. Scaffolded Differentiation Over Time	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjust supports over time because the unit materials include descriptions about how the SEP of Planning and Carrying Out Investigations will progress over the course of the unit. However, the reduction of teacher-provided scaffolding for **Constructing Explanations and Designing Solutions** and teacher guidance on where and when to remove scaffolding in order to guide all students (including those with special needs and abilities) towards independence lacked clarity.

The unit includes descriptions of student use of the SEP of **Planning and Carrying Out Investigations** and how the students' skills will become more complex over time in the element *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.* For example:

- In Lesson 1, teachers are provided guidance about the planned development of student understanding of investigations in the unit, beginning with grade 3–5 elements in early lessons and progressing through Grade 6–8 elements in later lessons (page 2).
- In Lesson 4, “Students use the 6.4_L04_Uncover_Student_PennyLaunchGuide (pages 1–2) to help PLAN investigation #1. The Teacher facilitates this process by leading the class through the Student Guide, and using the following prompting questions” (page 11).
- In Lesson 4, Investigation #2, students design their investigation with their group with “little or no facilitation from the teacher. The teacher provides less help as appropriate depending on class experience and abilities, and directs students to make their own inputs (page 14). Teacher then facilitates a consensus discussion with guiding questions provided to work on the element components of the SEP (page 16).
- In Lesson 5, students develop their egg drop investigation plan with their group. In this plan, students must identify variables but the data and tools are provided to them (page 12). Then, students are provided with the Connect Student Investigation 2 Graphic Organizer” for teams to plan their drop test investigation (page 19).
- In Lesson 5, students complete the Share Analysis Student Guide independently to assess student progress in the SEP (pages 17–18).
- In Lesson 6 (Connect Your Ideas), Unit Challenge Teams develop scientific investigations to test their cell phone case designs under both crushing and dropping conditions.
- Included in the unit materials is a link to Additional Resources to Support Teacher Background Knowledge which includes information for forces and motion and also includes links for SEP and CCC background information (page 6).

Suggestions for Improvement

- Consider adding teacher supports that provide help to all students (including those with special needs and abilities) as they work toward independence on the targeted SEP elements. In particular, consider providing support strategies for students struggling with the element, *Apply scientific ideas or principles to design, construct, and/or test a design of an object~~, tool, process or system~~*.
- Consider adding the kinds of support for developing student independence in all targeted SEP elements that are currently provided for this one **Planning and Carrying Out Investigations** element.

OVERALL CATEGORY II SCORE: **2** (0, 1, 2, 3)	
Unit Scoring Guide – Category II	
Criteria A-G	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

CATEGORY III

MONITORING NGSS STUDENT PROGRESS

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

III.E. COHERENT ASSESSMENT SYSTEM

III.F. OPPORTUNITY TO LEARN

“Protect Your Cell Phone”: Forces and Motion

EQuIP RUBRIC FOR SCIENCE EVALUATION

III.A. MONITORING 3D STUDENT PERFORMANCES

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena or design solutions because there are some opportunities to elicit direct, observable evidence that students integrate the three dimensions in service of sense-making and there are many rich, real-world, puzzling events and problems to solve. However, most tasks are two dimensional and match a DCI with either an SEP or CCC but not both.

Related evidence includes:

- Lesson 5: Students decide which landing surface would work best to protect/cushion a falling Ninja Warrior (pages 20–21). The “Rubric Level 3: Proficient” expects SEP and DCI proficiency. The CCC is assessed in the last two questions. These questions are focused primarily on the DCI and CCC — not the SEP. The rubric implies that correctly answering the last two questions and explaining stability and change would move students to advanced proficiency (Check Teacher Ninja Guide, page 4).
- Lesson 6: Students use their knowledge of collision forces to explain what causes more solid chocolate bunnies to become damaged during shipping, compared to otherwise identical, but hollow, chocolate bunnies (pages 19–20). Each dimension is assessed by the end of the assessment. However, only one or two dimensions are assessed by the individual questions. For example: Question 3 “During shipping, a bunny can fall from as much as 10 m height onto a hard floor. From the perspective of the bunny inside the shipping box, complete the: One object model of the hollow bunny, at the time of the collision with the floor. One Object model of the solid bunny, at the time of the collision with the floor.” This question assesses a portion of the DCI element and a portion of the CCC element. Question 4: Use the model and your knowledge of collision forces to describe why the solid chocolate bunnies are more likely to be damaged during shipping.” Exemplar of student response “The solid bunny has a larger mass so it experiences larger collision forces from a fall of the same height. The additional force on the solid bunnies causes more damage.” This response demonstrates some understanding of the DCI and requires application of SEP constructing explanation; however, the CCC of **System and System Models** is not directly applied therefore not assessed. (Check Teacher Bunny Guide, pages 1- 3).
- Lesson 3: Students use their knowledge to analyze balanced and unbalanced forces in a hydraulic press (page 20). The scoring rubric includes “Level 3: Proficient” and “Level 4:

Advanced.” However, students can earn a “Proficient” level rating without using the SEP element. In addition, the expectation listed in the rubric more closely matches a 3–5 grade band element of the SEP of **Planning and Carrying Out and Investigation** (Share Analysis Teacher Rubric, page 2). Although the materials mention that this SEP is scaffolded throughout Lesson 4, it does not make sense to label 3-5 grade level use as ‘advanced’ level performance.

- In Lesson 3, students add to their understanding of the dog sled from the previous lesson. Students are tasked with demonstrating understanding of what causes the change in motion (pages 23–24). The assessment rubric suggests proficiency if students demonstrate understanding of only DCIs and CCCs and do not answer the last question on designing a test. The SEP is only assessed in the last question, and answering this question suggests an advanced level of understanding.

Suggestions for Improvement

- Consider rewriting rubrics and assessments to ensure that the label of ‘proficiency’ for students requires all three dimensions working together, including the designing of solutions.
- Consider adding detailed directions on how teachers should record evidence about individual student progress during the student discussions including those during the Guiding Questions activity in each lesson.
- Consider including more opportunities for students to directly show their understanding of the CCCs within assessments. For example:
    - In Lesson 4, Unit Challenge; Crushing Investigation, students could be asked to use the targeted CCC so all three dimensions could be assessed.
    - In Lesson 4, “Bikini Bottom Tennis” there is a missed opportunity to assess the claimed CCC, **Stability and Change**. This could be done by modifying or adding a question that explicitly requires students to apply the lens of one of the Grade 6–8-level **Stability and Change** elements.
    - In Lesson 5, “Food Sources” there is a missed opportunity to assess the CCC of **System and System Models.**

III.B. FORMATIVE

Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials embed formative assessment processes throughout the unit that evaluate student learning and inform instruction because formative assessment opportunities are called out regularly throughout the unit. The assessments and teacher materials include accompanying guidance for teacher interpretation. However, reviewers found limited guidance for when and how to modify whole group instruction based upon assessment results.

Related evidence includes:

- A *Select Assessment Tools* document is provided that includes pre- and post-assessments, progress checks, a peer evaluation, and an exemplar for each assessment.
- Lesson 1: "Assessment: DCI - PS2-A Forces and Motion SEP - Asking Questions and Defining Problems CCC - Systems and System Models. Teachers will observe student groups and probe students to gage their prior understanding of criteria, constraints, and scientific knowledge, such as forces or system models, which they are using to define this problem and design a solution" (page 10). The guiding questions provided address all three dimensions.
- Lesson 2: An assessment opportunity for PS2.A and **Systems and System Models** is provided. Guiding questions are provided to assist the teacher in gauging students' understanding of the practices of modeling a static system. At this point in the instructional plan, there is no description provided on how these assessments will be used to inform instruction.
- Lesson 4: A formal Mi-STAR Embedded Assessment is completed individually by students in order to apply their understandings of planning a scientific investigation and forces and motion to a different scenario.
- Lesson 5: "Summary of Reteaching Support Found Within Lesson Phases: (DCI - MS PS2-1, MS PS2-2; SEP - Planning and Carrying Out Investigations and Constructing Explanations and Designing Solutions; CCC - Stability and Change) If assessment activities found within this lesson (guiding questions, analysis questions, embedded assessment results) reveal that students are struggling with the DCI, SEP, or CCC components found in this lesson, then the following activities may be used to reteach or reinforce lesson components: Full list of reteaching support for 6.4"(page 22).
- Lesson 6: "Analysis questions may be used as an interim Check Your Progress if a lesson takes several days to complete. Analysis questions could also be assigned as homework, used as exit slips, or used as a diagnostic tool to inform instruction" (page 15).

Suggestions for Improvement

- Consider adding more culturally and linguistically diverse response opportunities for students.
- Consider accompanying rubrics with supports for informing instruction based on student responses.
- Consider adding or labeling additional tasks as optional based upon formative assessment results (rather than time) and linking to interpretation for each dimension.
- Consider providing more procedures and details on how to assess the informal formative assessments such as models in student notebooks and group discussions using the Guiding Questions.

III.C. SCORING GUIDANCE

Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

Rating for Criterion III.C. Scoring Guidance	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions because unit materials provide a variety of scoring guidance for teachers and target elements of each dimension. However, teachers are not provided with a range of student responses and guidance to ensure that students can understand and monitor their own progress toward the targets.

Related evidence includes:

- A Unit Summary Table Rubric is provided to use for Lessons 2–6. It provides five levels from not evident to advanced and includes a description of what should be included at each level of performance. A set of example student responses for Row C "My answer to the lesson discovery question" on the Unit Summary worksheet are provided only for Lesson 2. Each Unit Summary for Lessons 2–6 provide a teacher key, and key information that should be included in student responses or pre-filled by teachers "May be partially or completely filled out by the teacher at their discretion." A set of example student responses for Row C "My answer to the lesson discovery question" on the Unit Summary worksheet are provided for Lesson 2: "Example Student Responses: Student responses below are for lesson 2 only to be used for guidance for subsequent lessons" (T3_6.4_UnitSummaryTable_Teacher/Rubric, page 7).
- A rubric is provided for each question of the Pre/Post Assessment. Each rubric includes levels of performance and descriptions of the criteria for each level.

- Lessons 2 and 3: A Check Your Progress assessment is provided at the end of the lesson and asks students to apply their learning to a new situation. They must describe force pairs related to how a sled hook is used to hold a racing dog sled from moving as dogs are being harnessed to the sled. The Lesson 3 Check Your Progress assessment asks students how a foot brake applies a force to hold a dog sled against the force of a pulling dog. Scoring rubrics are provided.
- Lesson 7: Students use a rubric to provide peer feedback. Teachers are provided with a separate document that includes the same questions, rubrics with sample student responses and teacher notes. “Teacher note – The students will be collecting data in Question 6 through 8 to assess student learning of the selected Unit Key Concepts and Practices” (6.4_L07_Share_Teacher_UCAssessment_PeerEvaluationRubric, page 1).

Suggestions for Improvement

- Rather than only providing an answer key, consider providing a more leveled exemplar so teachers could see what responses may look like from students who are responding at each level of proficiency.
- Consider including progress trackers so students would be able to interpret their progress toward meeting the goals set forth in the lesson. Currently, all feedback on scoring is at the teacher level and not written for students.
- Consider including a set of sample student responses for Row C on the Unit Summary Table for all lessons. Also, consider including guidance on when and how student artifacts will be evaluated by including scoring guidance and processes for providing feedback for all assessment opportunities.

III.D. UNBIASED TASK/ITEMS

Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because tasks are varied, text volume and vocabulary are grade-appropriate, and there are multiple ways for students to engage with the learning. However, a majority of tasks require a written response and do not provide student choice in modality of their response.

Related evidence includes:

- Lesson 2: The Share Analysis Student Copy provides students with a written prompt. Students are given the branch, bird, and system boundary and prompted to complete the model. Then students are asked to describe how the forces between the bird and branch allow it to be stable. All questions that follow are written prompts.
- Lesson 5: Share Analysis Student Copy students use a simulation to explore collisions. Then, students are prompted to add force vectors to a model with the car bumpers already place. All questions that follow are written prompts that ask for a written response.
- Lesson 7: “The Unit Challenge Teams compile a unit challenge poster using resources they created during this lesson as well as resources they’ve created previously… Alternative presentation methods may be utilized at teacher/student discretion. Alternative presentation methods are encouraged as class resources and interests permit, so that students have a variety of ways to convey their understanding, e.g., video or vlog, photo journal” (page 9).

Suggestions for Improvement

- Consider asking students to represent their thinking in a method of their choice versus defaulting to asking them to describe their answers in written format. For example, students may be able to respond to some prompts by using a video, image, or oral presentation.
- Consider accompanying text-based prompts with other methods to ensure that students understand the question and task prompts e.g., visual representations.
- Background communication materials mention removing the space shuttle thrusters scenario from the Pre/Post Assessment, as it may be unfamiliar to some students. However, this question is still in the provided assessment linked in Lesson 1. Consider removing this prompt and scenario.

III.E. COHERENT ASSESSMENT SYSTEM

"Protect Your Cell Phone": Forces and Motion

EQuIP RUBRIC FOR SCIENCE EVALUATION

Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.	
Rating for Criterion III.E. Coherent Assessment System	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because all of these assessment types are included, are aligned to the learning goals, and require students to apply grade appropriate elements to make sense of phenomena. However, it is not clear that the assessment items adequately assess students' use of the targeted CCCs.

Related evidence includes:

- A Pre/Post Assessment is provided along with an Assessment Overview Table, which details each of the DCIs, SEPs, and CCCs that are included and which assessment item addresses each of the three dimensions. Student exemplar responses are included. However, the Assessment Overview Table does not specify the elements or portion of the elements being assessed by each question; the elements are listed separately under the Overview Table (6.4_PrePost_Assessment_TeacherCopy, page 1). Multiple, frequent formative assessment opportunities are provided in each lesson. These include Check Your Progress, Guiding Questions, and Analysis Questions:
    - Check Your Progress exercises can be used to gauge student understanding. These exercises ask students to apply their newly acquired understanding to different, related scenarios. For example:
        - Lesson 2 and 3: A Check Your Progress assessment is provided at the end of the lesson and asks students to apply their learning to a new situation. They must describe force pairs related to how a sled hook is used to hold a racing dog sled from moving as dogs are being harnessed to the sled.
        - The Lesson 3 Check Your Progress assessment asks students how a foot brake applies a force to hold a dog sled against the force of a pulling dog. A rubric is provided. However, no descriptions about how to provide student feedback are given.
    - Guiding Questions are provided multiple times in each lesson and are "suggested questions intended for use with individuals or with groups/classes to assess student understanding of the lesson content located in each lesson phase" (Select Assessment Tools, page 1). Although the Guiding Questions in each lesson are thorough and detailed, guidance on how feedback should be used by students to inform learning is not explicit. Analysis Questions are provided in each lesson and "…may be used as an interim Check Your Progress if a lesson takes several days to complete. Analysis questions could also be assigned as homework, used as exit slips, or used as a diagnostic

tool to inform instruction” (Lesson 5, page 17). For example, the Uncover Analysis Questions Student Guide for Lesson 5 includes an opportunity for students to apply their learning about planning investigations and about balanced and unbalanced forces to an everyday scenario of cracking an egg.

- Self-Assessment is provided for Lessons 2–6 in the “Gotta Have Checklist” for students. Students are encouraged to complete rows C and D of their Summary Tables following each lesson using Science Words and the Gotta Have Checklist. For example, Lesson 3: “How balanced forces exerted on an object result in the object being stable. How unbalanced forces on objects cause a change in shape (sometimes damaging) and/or change in motion.” Lesson 4: “How to plan an investigation” “How to conduct a scientific investigation” (T3_6.4_CompiledGottaHaveChecklist).

Suggestions for Improvement

- Consider including a more explicit formal assessment system that describes how the different types of assessment work together to provide feedback to teachers to inform instruction and feedback to students to advance their learning.
- In the Assessment Overview Table, consider listing the assessed element of each dimension.
- Consider providing opportunities for students to develop the “Gotta Have Checklist” as a class. This could increase student agency compared to students always being provided with what should be expected in their response by the teacher.

III.F. OPPORTUNITY TO LEARN

Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback.

Rating for Criterion III.F. Opportunity to Learn	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts. The unit gives students multiple, connected opportunities to demonstrate their proficiency throughout the course of the lessons. However, the reviewers found minimal support for teachers in how and when to provide feedback and how and when students could use the feedback to grow in their understanding.

Related evidence includes:

- Lesson 3: Students participate in a gallery walk to compare tower testing models among the student groups and then review a teacher presentation on Object Modeling and their limitations. Students then revise their initial models, developing One Object force models to explain why the tower is crushed by the books (page 14).
- Lesson 7: Students use a peer evaluation rubric. “Students individually evaluate another Unit Challenge Team’s final product, using the Share Student UCAssessment_PeerEvaluationRubric. Students then work in teams “to revise their own posters based on feedback from others.” An optional activity is provided for further reflection. “Students write a reflection about any changes they would make to either their investigation plans or their physical design. Students include evidence and reasoning to support their changes. (Lesson Plan, page 11).
- Unit 6.4 Summary Table provides an overview of the lesson activities, evidence gathered, and opportunities for students to connect ideas to the unit challenge. For example, Lesson 3: “What Activity Did We Do?: We designed and built towers out of paper and tested them to see how well they supported a stack of books.” “My answer to the lesson discovery question: When an object is stable, the forces on that object are balanced, that is they cancel each other out when we take magnitude and direction into account. When there are unbalanced forces on an object, the object motion changes and/or it changes shape.” Connecting my ideas to the unit challenge: We can use what we learned about the paper towers to help design a test that could test a phone for crushing. The case needs to be strong enough to provide forces acting upward against the downward weight of the books so the stack of books will remain stable. If the case can’t do this, the forces on the case will be unbalanced, the books will move downward and change shape (be crushed) (6.4_UnitSummaryTable_Teacher/Rubric, page 2).

Suggestions for Improvement

- Consider adding suggestions for when and how to provide feedback to students (based on their force models and all other assessment opportunities) and how students can reflect on and use the feedback to make further progress towards the targeted elements of the three dimensions. This could include opportunities to make corrections to move their thinking forward throughout the unit.
- Consider providing opportunities for students to peer critique each other’s model more frequently throughout the lessons and then give time for students to make revisions and explain why the revision more accurately represents their understanding.

OVERALL CATEGORY III SCORE: **2** (0, 1, 2, 3)

Unit Scoring Guide – Category III	
Criteria A-F	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

UNIT SCORING GUIDE – CATEGORY I (CRITERIA A-F)

UNIT SCORING GUIDE – CATEGORY II (CRITERIA A-G)

UNIT SCORING GUIDE – CATEGORY III (CRITERIA A-F)

OVERALL SCORING GUIDE

Scoring Guides for Each Category

Unit Scoring Guide – Category I (Criteria A-F)	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

Unit Scoring Guide – Category II (Criteria A-G)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

Unit Scoring Guide – Category III (Criteria A-F)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

OVERALL SCORING GUIDE	
E	**Example of high quality NGSS design—**High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)
E/I	**Example of high quality NGSS design if Improved—**Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)
R	**Revision needed—**Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)
N	**Not ready to review**—Not designed for the NGSS; does not meet criteria (total 0–2)