Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science
Unit 1 End of Unit Assessment Design Patterns
Forces and Energy
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SIPS Grade 8 Unit 1 End of Unit Assessment Design Patterns (MS-PS2-1, MS-PS2-2, MS-PS2-4, MS-PS3-1)

Grade 8 SIPS Design Pattern for MS-PS2-1

Element	Description
Knowledge and Practices (DCI, SEP, CCC)	In this task, students: • describe that 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). • apply scientific ideas or principles to design an object, tool, process or system to demonstrate understanding of the core ideas. The crosscutting concept of using models to represent systems and their interactions (such as inputs, processes, and outputs) and energy and matter flows within systems is the organizing concept for the disciplinary core ideas.
Performance Expectation	**MS-PS2-1.** Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] *[Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]*
Knowledge, Skills, & Abilities (KSAs)	**KSA1:** Develop a model to represent the motion of objects in colliding systems and their interactions (e.g., inputs, processes, and outputs, as well as energy and matter flows within systems). **KSA2:** Describe a design approach as a possible solution to a problem involving the motion of two colliding objects. **KSA3:** Explain how the relevant scientific ideas are taken into account within a design approach to a problem involving the motion of two colliding objects. **KSA4:** Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects. **KSA5:** Use a model to generate data to test ideas about designed systems, including those representing inputs and outputs. **KSA6**: Apply Newton's third law to identify the scientific principle (e.g., action-reaction forces) that supports the effectiveness of the design.
Student Demonstration of Learning	• Model accurately represents the observable phenomena. • Develop and/or use a model to determine a design solution to a problem.

	• Model and response accurately describe the given criteria and constraints, including how they will be taken into account when designing the solution. • Correctly identifies and describes relevant components of the model. • Determine how well the design solution meets the criteria and constraints, based upon an understanding of Newton's third law. • Analyze and interpret data to determine how a design best minimizes collision force.
Work Product	• Draw a model to describe phenomena. • Interpretation of data. • Graph quantities. • Complete a model. • Constructed response. • Selected response.
Task Features	• The task focuses on performances for which students' opportunity to learn has prepared them. • The task is based on the assessed KSA(s) and driven by a high-quality scenario that focuses on a phenomenon or design problem. • The task scenario is grounded in the phenomena and problems being addressed. • The task provides ways for students to make connections of meaningful local, global, or universal relevance. • The task scenario is sufficient, engaging, relevant, and accessible to a wide range of students. • The task is accessible, appropriate, and cognitively demanding for all learners, including students with disabilities, and students who are English learners or are working below or above grade level. • All prompts within a task are fair and equitable and include a range of presentation and response modes. • The task requires students to use scientific reasoning and process skills to produce evidence that can be used by educators to make inferences about student learning. • The task requires students to use reasoning and integrate multiple dimensions (i.e., SEP, DCI, CCC) to support sense-making about phenomena or problems. • The task uses information that is scientifically accurate. • The task uses active voice and present tense. • The task is written at or below grade level. • The task requires students to develop a model to collect evidence. • The task requires students to produce data to be used as evidence to support the change in an object's motion depending on the sum

	of the forces on the object and the mass of the object including qualitative comparisons of forces, mass, and changes in motion. ● The task requires students to measure and describe quantities such as weight, time, and speed. ● The task requires students to make observations and measurements to produce data that can serve as the basis for evidence that the design solution is appropriate to solve the given problem. ● The task requires students to make observations and measurements to generate relevant patterns of evidence for answering the scientific question or for supporting the model.
Variable Features (Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus.)	● Complexity of scientific concept(s) to be modeled. ● Phenomenon addressed in the scenario, including but not limited to: ○ Crumple zones in cars to reduce damage in accidents. ○ Airbag deployment. ○ Meteorite impacts. ○ Space flight applications. ○ Force required to break an object. ● Domain-specific vocabulary and definitions. ● Format of "real-world" phenomenon under investigation: image, data, text, combination. ● Function of the model: ○ To explain a mechanism underlying a phenomenon. ○ To predict future outcomes. ○ To describe a phenomenon. ○ To generate data to inform how the world works. ● Degree to which components of the model are provided. ● Model may be student-created or provided for revision or creation. ● Representation of model. ● Use or purpose of the model. ● Type of model (e.g., physical/virtual). ● Nature of the investigation: ○ To explain a mechanism underlying a phenomenon. ○ To predict future outcomes. ○ To describe a phenomenon. ○ To generate data to inform how the world works. ● Examples of scenarios could include the impact of collisions: ○ Between two cars. ○ Between a car and stationary objects.

	○ Between a meteor and a space vehicle.
Assessment Boundaries	• Assessment is limited to vertical or horizontal interactions in one dimension. • Students are not expected to know concepts related to momentum. • Task does not require students to use vectors such as velocity. • Task does not include the formula for the kinetic energy of an object or require students to make calculations using the formula.
Technical Terms	• Motion, speed, velocity, acceleration, force, balanced force, unbalanced force, collision, Newton's third law of motion, position, direction, mass

Grade 8 SIPS Design Pattern for MS-PS2-2

Element	Description
Knowledge and Practices (DCI, SEP, CCC)	In this task, students: • understand that the motion of an object is determined by the sum of the forces acting on it; and if the total force on the object is not zero, its motion will change. • understand that the greater the mass of the object, the greater the force needed to achieve the same change in motion. • understand that for any given object, a larger force causes a larger change in motion. • understand that 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. • plan investigations and identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how much data are needed to support a claim to demonstrate understanding of the core ideas. The crosscutting concept of stability and change in natural or designed systems by examining the changes over time and forces at different scales is the organizing concept for the disciplinary core ideas.
Performance Expectation	**MS-PS2-2.** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass, and changes in motion (Newton's Second Law), frame of reference, and specification of units.] *[Assessment Boundary: Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]*
Knowledge, Skills, & Abilities (KSAs)	**KSA1:** Design an investigation and identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how much data are needed to support a claim that an object's motion depends on the sum of the forces on the object and the mass of the object. **KSA2:** Explain how the change in motion of an object (i.e., changes over time and forces at different scales) is due to balanced or unbalanced forces acting on the object. **KSA3:** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. **KSA4:** Make logical and conceptual connections between evidence and explanations of stability and change in an object's motion.

Student Demonstration of Learning	● Correctly identify the evidence necessary to address the purpose of an investigation. ● Use appropriate units. ● Correct use of quantitative and qualitative data to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. ● Generate and support a solution with evidence. ● Identify a solution that is most likely to be successful.
Work Product	● Interpretation of data ● Graph quantities ● Selected response ● Constructed response
Task Features	● The task focuses on performances for which students' opportunity to learn has prepared them. ● The task is based on the assessed KSA(s) and driven by a high-quality scenario that focuses on a phenomenon or design problem. ● The task scenario is grounded in the phenomena and problems being addressed. ● The task must prompt students to make connections between the observed phenomena or evidence and the reasoning underlying the observation/evidence. ● The task provides ways for students to make connections of meaningful local, global, or universal relevance. ● The task scenario is sufficient, engaging, relevant, and accessible to a wide range of students. ● The task is accessible, appropriate, and cognitively demanding for all learners, including students with disabilities, and students who are English learners or are working below or above grade level. ● All prompts within a task are fair and equitable and include a range of presentation and response modes. ● The task requires students to use scientific reasoning and process skills to produce evidence that can be used by educators to make inferences about student learning. ● The task requires students to use reasoning and integrate multiple dimensions (i.e., SEP, DCI, CCC) to support sense-making about phenomena or problems. ● The task uses information that is scientifically accurate. ● The task must elicit core ideas as defined in the PE. ● The task uses active voice and present tense. ● The task is written at or below grade level. ● The task requires students to produce data to be used as evidence to support the change in an object's motion depending on the sum

	of the forces on the object and the mass of the object including qualitative comparisons of forces, mass, and changes in motion. ● The task requires students to measure and describe quantities such as weight, time, and speed.
Variable Features (Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus.)	● Complexity of scientific concept(s) to be modeled. ● Domain-specific vocabulary and definitions. ● Phenomenon addressed in the scenario, including but not limited to: ○ Comparing and contrasting different motion graphs (position vs. time or velocity vs. time) of specific physical situations. ○ Acceleration vs. unbalanced force graph. ○ Unbalanced force vs. mass graph. ○ Cart put into motion by unbalanced forces (e.g., pushed by a spring-loaded plunger or pulled on a string). ○ Cart-pulley-mass system on a ramp. ○ Block sliding across the surface as it is pulled by a force applied to a spring scale. ● Format of "real-world" phenomenon under investigation: image, data, text, combination. ● Standard units used (e.g., grams, liters). ● Amount and type of presented observations and/or measurements.
Assessment Boundaries	● Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to change in one variable at a time. ● Students are not expected to use trigonometry. ● Task does not require students to use vectors such as velocity. ● Task does not include the formula for the kinetic energy of an object or require students to make calculations using the formula.
Technical Terms	● Motion, speed, velocity, acceleration, force, balanced force, unbalanced force, collision, Newton's first law of motion, Newton's second law of motion, position, direction, mass, control, dependent variable, independent variable, trials, external force, frame of reference

Grade 8 SIPS Design Pattern for MS-PS2-4

Element	Description
Knowledge and Practices (DCI, SEP, CCC)	In this task, students: • describe how gravitational forces are always attractive. • understand that there is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass. • construct arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem to demonstrate understanding of the core ideas. The crosscutting concept of using models to represent systems and their interactions (such as inputs, processes, and outputs) and energy and matter flows within systems is the organizing concept for the disciplinary core ideas.
Performance Expectation	**MS-PS2-4.** Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] *[Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]*
Knowledge, Skills, & Abilities (KSAs)	**KSA1:** Support a claim with evidence related to the idea that gravitational interactions are attractive and depend on the masses of interacting objects. **KSA2:** Use reasoning to explain how relevant evidence/data supports or refutes the claim related to the idea that gravitational interactions are attractive and depend on the masses of interacting objects. **KSA3:** Use a model to identify the variables associated with gravitational interactions. **KSA4:** Identify and represent, using models such as force diagrams, the relative magnitude and direction of the force each object exerts on the other. **KSA5:** Identify proportional relationships of mass and gravitational force using data to construct an argument. **KSA6:** Use proportional relationships of mass and/or distance and gravitational force(s) using data to make a prediction.
Student Demonstration of Learning	• Correctly identifies evidence that supports a claim that gravitational interactions are attractive and depend on the masses of interacting objects.

	● Use reasoning to explain how some effects of gravitational interactions, which apply universally, may only be observable in interactions between very massive objects. ● Correctly identifies variables in a model associated with gravitational interactions. ● Constructs a sound argument that mass increases the magnitude of gravitational force.
Work Product	● Interpretation of data ● Interpretation of model ● Tables ● Graph quantities ● Draw/describe model ● Selected response ● Constructed response
Task Features	● The task focuses on performances for which students' opportunity to learn has prepared them. ● The task is based on the assessed KSA(s) and driven by a high-quality scenario that focuses on a phenomenon or design problem. ● The task scenario is grounded in the phenomena and problems being addressed. ● The task provides ways for students to make connections of meaningful local, global, or universal relevance. ● The task scenario is sufficient, engaging, relevant, and accessible to a wide range of students. ● The task is accessible, appropriate, and cognitively demanding for all learners, including students with disabilities, and students who are English learners or are working below or above grade level. ● All prompts within a task are fair and equitable and include a range of presentation and response modes. ● The task requires students to use scientific reasoning and process skills to produce evidence that can be used by educators to make inferences about student learning. ● The task requires students to use reasoning and integrate multiple dimensions (i.e., SEP, DCI, CCC) to support sense-making about phenomena or problems. ● The task uses scientifically accurate information. ● The task uses active voice and present tense. ● The task is written at or below grade level. ● The task requires students to use scientific reasoning and process skills in observational (non-experimental) investigations. ● All tasks must elicit core ideas as defined in the PE.

	● All tasks must include elements from at least two dimensions of the NGSS. ● The task requires that the data provide enough evidence to support an explanation. ● The task requires students to use data that can serve as the basis for evidence for answering the scientific question or for supporting the model.

Variable Features (Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus.)	● Complexity of scientific concept(s) to be modeled.
	● Domain-specific vocabulary and definitions.
	● Format of "real-world" phenomenon under investigation: image, data, text, combination.
	● Phenomenon addressed in the scenario, including but not limited to:
	    ○ The magnitudes of the gravitational forces exerted on interacting objects are not equal, with the smaller mass receiving a larger force and the larger mass receiving a smaller force.
	    ○ Gravitational force only applies to large objects such as planets and stars.
	    ○ There is no gravity in space.
	● Function of the model:
	    ○ To explain a mechanism underlying a phenomenon.
	    ○ To predict future outcomes.
	    ○ To describe a phenomenon.
	    ○ To generate data to inform how the world works.
	● Degree to which components of the model are provided.
	● Model may be provided for revision or created.
	● Representation of model.
	● Use or purpose of the model.
	● Type of model (e.g., physical/virtual).
	● Standard units used (e.g., grams, liters).
	● Amount and type of presented observations and/or measurements.
	● Range of data provided.
	● Complexity of data provided.
	● Use or purpose of creating a graphical display.
	● Type and number of system(s).
	● Components within a system.
	● Standard units used.
	● Type of graph.
	● Degree in which mathematical equations are used.
	● Complexity in which values or relationships are predicted.

	• Types of sources of evidence.
Assessment Boundaries	• Assessment does not include Newton's Law of Gravitation or Kepler's Laws.
Technical Terms	• Mass, weight, gravity, kinetic energy, gravitational potential energy, gravitational interactions, systems

Grade 8 SIPS Design Pattern for MS-PS3-1

Element	Description
Knowledge and Practices (DCI, SEP, CCC)	In this task, students: • describe that motion energy, called kinetic energy, is proportional to the mass of the moving object and grows with the square of its speed. • construct and interpret graphical displays of data to identify linear and nonlinear relationships to demonstrate understanding of the core ideas. The crosscutting concept of using proportional relationships among different types of quantities is the organizing concept for the disciplinary core ideas.
Performance Expectation	**MS-PS3-1.** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]
Knowledge, Skills, & Abilities (KSAs)	**KSA1:** Construct a graphical display showing the relationship between kinetic energy and mass. **KSA2:** Construct a graphical display showing the relationship between kinetic energy and speed. **KSA3:** Interpret a graph to state that kinetic energy and mass have a linear relationship. **KSA4:** Interpret a graph to state that kinetic energy and speed have a nonlinear relationship. **KSA5:** Identify proportional relationships of kinetic energy and the mass of an object by analyzing a graphical display/data. **KSA6:** Use proportional relationships of kinetic energy and the mass of an object by analyzing graphical displays/data to make a prediction. **KSA7:** Identify proportional relationships of kinetic energy and the speed of an object using data. **KSA8:** Use proportional relationships of kinetic energy and the speed of an object using data to make a prediction. **KSA9:** Construct and interpret a graphical display to compare the relationship between kinetic energy and mass to the relationship between speed and kinetic energy.
Student Demonstration of Learning	• Correctly identifies the relationship between kinetic energy and the speed of an object as nonlinear. • Correctly identifies the relationship between kinetic energy and the mass of an object as linear.

	• Correctly identifies proportional relationships of kinetic energy and the mass of an object by analyzing data. • Correctly identifies the proportional relationships of kinetic energy and the speed of an object by analyzing data. • Accurately constructs graphical displays showing the relationships between kinetic energy and mass. • Accurately construct graphical displays showing the relationships between kinetic energy and speed. • Accurately interprets data comparing the relationship of kinetic energy and mass to the relationship of speed and kinetic energy by creating an algebraic expression. • Accurately predicts a value using data that shows the proportional relationship between kinetic energy and mass. • Accurately predicts a value using data that shows the proportional relationship between kinetic energy and speed. • Graphs relationships and describes the relationship shown by the graph as linear or non-linear.
Work Product	• Interpretation of data • Graphs • Selected response • Constructed response
Task Features	• The task focuses on performances for which students' opportunity to learn has prepared them. • The task is based on the assessed KSA(s) and driven by a high-quality scenario that focuses on a phenomenon or design problem. • The task scenario is grounded in the phenomena and problems being addressed. • The task provides ways for students to make connections of meaningful local, global, or universal relevance. • The task scenario is sufficient, engaging, relevant, and accessible to a wide range of students. • The task is accessible, appropriate, and cognitively demanding for all learners, including students with disabilities, and students who are English learners or are working below or above grade level. • All prompts within a task are fair and equitable and include a range of presentation and response modes. • The task requires students to use scientific reasoning and process skills to produce evidence that can be used by educators to make inferences about student learning. • The task requires students to use reasoning and integrate multiple dimensions (i.e., SEP, DCI, CCC) to support sense-making about phenomena or problems. • The task uses information that is scientifically accurate.

	● The task uses active voice and present tense. ● The task is written at or below grade level. ● The task requires that the data provide enough evidence to support an explanation. ● The task requires students to use data that can serve as the basis for evidence for answering the scientific question or for supporting the model.
Variable Features (Aspects of an assessment task that <u>can be varied</u> to shift complexity or focus.)	● Complexity of scientific concept(s) to be modeled. ● Domain-specific vocabulary and definitions. ● Format of "real-world" phenomenon under investigation: image, data, text, combination. ● Phenomenon addressed in the scenario, including but not limited to: ○ Damage is done by objects of different masses moving at the same speed or objects of the same mass moving at different speeds. ○ Distance traveled after objects of different masses roll down a ramp, released from a catapult, or some other source of kinetic energy. ○ Measurement of an object’s speed and associated kinetic energy as the object moves along a path. ○ Kinetic energy of objects of different mass on top of a ramp. ○ Kinetic energy of objects in free fall. ● Range of data provided. ● Complexity of data provided. ● Use or purpose of creating a graphical display. ● Type and number of system(s). ● Components within a system. ● Standard units used. ● Type of graph. ● Degree in which mathematical equations are used. ● Complexity in which values or relationships are predicted. ● Types of sources of evidence.
Assessment Boundaries	● Assessment is limited to the proportional relationships of kinetic energy to the mass of an object and kinetic energy to the speed of an object. ● Assessment does not require students to calculate slopes or determine functions of graphical displays. ● The task does not require students to use vectors such as velocity. ● The task does not include the formula for the kinetic energy of an object or require students to make calculations using the formula.

Technical Terms	• Motion, speed, velocity, acceleration, force, balanced force, unbalanced force, collision, position, direction, mass, weight, kinetic energy, gravitational potential energy, proportional, linear and nonlinear relationships, acceleration

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