Rigorous Curriculum Design

Unit Planning Organizer

Subject:	**Science**			Grade:	**8**
Unit Number:	**3**	Unit Name:	**Kinetic and Potential Energy**		
Unit Length	**Days: 15-20 (3-4 weeks)**		**Mins/Day: 55**		
Unit Synopsis	**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.** **Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.**				

	NGSS	Science and Engineering Practice(s)
Priority Performance Expectations	**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. **PS3-2** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. **Assessment Boundaries**:	• **Analyze and Interpret Data (PS3-1)** • **Develop and Use Models (PS3-2)** Disciplinary Core Ideas **PS3.A: Definitions of Energy** • Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) • A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2) **PS3.C: Relationship Between Energy and Forces** • When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)
Crosscutting Concepts	**Scale, Proportion, and Quantity (PS3-1)** **Systems and System Models (PS3-2)**	

	NGSS	Math CCSS	Literacy CCSS
Supporting Performance Expectations	**MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MP.2** Reason abstractly and quantitatively. (MS-PS3-1) **6.RP.A.1** Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1) **6.RP.A.2** Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. *(MS-PS3-1)* **7.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-PS3-1) **8.EE.A.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1) **8.EE.A.2** Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots	**RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. *(MS-PS3-1)* **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1) **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-PS3-2)*

		of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. *(MS-PS3-1)*	

	NG ELD Standards	Literacy / Science / History / Other
Interdisciplinary Connections		**MS.PS2.A**

Unwrapped Priority Performance Expectations

PE: MS-PS3-1				
Skills	Concepts	Bloom's	DOK (Rigor Matrix)	Language Demand
Construct	graphical displays of data	Create	3	
interpret		Analyze		
To describe	relationships of kinetic energy to the mass and speed of an object	Analyze		

PE: MS-PS3-2 Skills	Concepts	Bloom's	DOK (Rigor Matrix)	Language Demand
Develop	a model	Create	3	
To describe	when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.	Analyze		

Learning Progressions of Skills and Concepts

PE: DCI(s):	**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.**	
Previous Course 4th Grade	Current Course	Next Course High School
4.PS3.B		**H.S.PS3.A** **H.S.PS3.B**

PE:	**PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.**	
DCI(s):		
Previous Course NA	Current Course	Next Course High School
NA		**H.S.PS2.B** **H.S.PS3.B** **H.S.PS3.C**

Big Idea(s)	Corresponding Essential Question(s)

1. **PS3-1**: Objects with greater mass have greater amount of kinetic energy than objects with less mass. 2. **PS3-1**: Objects with greater speed have greater amount of kinetic energy than objects will less speed. 3. **PS3-1**: Amount of kinetic energy depends on the speed and mass of moving objects. 4. **PS3-2**: Potential energy depends on an object's relative distance or height from the ground. 5. **PS3-2**: Potential energy can be changed by changing relative distance of an object. 6. **PS3-2**: Increasing relative distance of an object will change its potential energy.	1. **PS3-1:** Why is it harder to stop a bowling ball rolling down a hill than a golf ball? 2. **PS3-1**: Why does a bullet do more damage than a tennis ball? 3. **PS3-1**: When can a tennis ball hurt more than a bowling ball? 4. **PS3-2**: When does a roller coaster have the greatest amount of potential energy? 5. **PS3-2**: How can you change potential energy in a rubber band. 6. **PS3-2**: How does distance affect potential energy?
Unit Vocabulary Words	
Academic Cross-Curricular Vocabulary (Tier 2)	Content/Domain Specific Vocabulary (Tier 3)
1. Energy 2. Kinetic 3. Static 4. Potential 5. Relationship 6. Speed 7. Mass 8. Proportional 9. Motion 10. Relative position 11. Average 12. system	1. Kinetic energy 2. Potential energy
Supporting Vocabulary (Tier 2)	Supporting Vocabulary (Tier 3)
1. Height	

Resources for Vocabulary Development (Strategies, Routines and Activities)			
1. Post vocabulary around the room 2. Require using	4. Highlighting vocabulary terms 5. Construct picture	7. Using terms in different context 8. Using graphic	10. Word splatter 11. Vocabulary web: definition,

vocabulary terms in written and verbal responses. 3. Use vocabulary notecards/foldables	or graphic representation of term 6. Peer study/quiz vocab terms	organizer 9. Prefixes/word root	sentence, illustration, example 12. Looping vocab cards

21st Century Skills	
☐ Creativity and Innovation	☐ Initiative and Self-Direction
☐ Critical Thinking and Problem Solving	☐ Social and Cross-Cultural Skills
☐ Communication and Collaboration	☐ Productivity and Accountability
☐ Flexibility and Adaptability	☐ Leadership and Responsibility
☐ Globally and Financially Literate	☐ _____
☐ Communicating and Collaborating	☐ _____

Connections between 21st Century Skills, NGSS, and Unit Overview:

Costa & Kallick, 2008

Unit Assessments	
Pre-Assessment	Post-Assessment
See EADMS for assessment "AUSD NGSS 08 Unit 3 Pre"	See EADMS for assessment "AUSD NGSS 08 Unit 3 Post"
Scoring Guides and Answer Keys	
Unit 3 8th Grade assessment_planner_science.docx	Unit 3 8th Grade assessment_planner_science.docx

Assessment Differentiation			
Students with	***Accommodations*** Reference IEP to ensure appropriate testing environment	English Language	Emerging

	Modifications		Expanding

Engaging Scenario Overview (Situation, challenge, role, audience, product or performance)	
Description: You are a beach front property developer in need of customers for your new sea side attraction. Your challenge is to build a successful, exciting and safe rollercoaster. You will be expected to research, design, build, and publicize your rollercoaster to an audience of community members and advertising agents.	Suggested Length of Time Days: 10-15 Mins/Day:

Engaging Learning Experiences Synopsis of Authentic Performance Tasks		
Authentic Performance Tasks	Description	Suggested Length of Time
Task 1: Identify the forces affecting a rollercoaster in the following situations: At the top of a hill, at the bottom of a hill, in a loop, and in a turn.	Problem Solving: Identify forces, including potential and kinetic energy, as they pertain to rollercoaster physics SEP: Constructing Explanations and Designing Solutions • **Analyze and Interpret Data (PS3-1)**	Days: 1 Mins/Day: 60
Task 2: Design a successful rollercoaster using a computer simulation taking into account potential and kinetic energy of the cars along the	Problem Solving: Identify flaws in design and find solutions SEP: Using Mathematics and Computational Thinking Developing and Using Models • **Analyze and Interpret Data (PS3-1)** • **Develop and Use Models (PS3-2)**	Days:1-2 Mins/Day:

track. Task 3: Build a model rollercoaster using paper templates.	Problem Solving: Identify flaws in design and find solutions SEP: Developing and Using Models Constructing Explanations and Designing Solutions • **Develop and Use Models (PS3-2)**	Days:5-8 Mins/Day:
Task 4: Design and create an advertising campaign for your coaster including a public advertisement, a news article or presentation, and an article for a professional journal	Problem Solving: Anticipate the needs and expectations of various audiences while informing each audience of the details and physics of a rollercoaster SEP: Obtaining, Evaluating, and communicating Information • **Develop and Use Models (PS3-2)**	Days: 3-5 Mins/Day:

Authentic Performance Task 1

Name:	Identifying forces on a rollercoaster	Suggested Length	Days: 1 Mins/Day:
	Priority Standards		
	NGSS	Science and Engineering Practice(s)	
Performance Expectations / Standards Addressed	**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.	**Analyze and Interpret Data** **Develop and Use Models**	
		Disciplinary Core Idea(s)	
		PS3.A: Definitions of Energy Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. A system of objects may also contain stored (potential) energy, depending on their relative positions.	
		Crosscutting Concept(s)	

			Systems and System Models (PS3-2)	
	Supporting Standards			
	NGSS	CCSS Math	CCSS Literacy	NG ELD

Teaching and Learning Progression	Identify the forces affecting a rollercoaster in the following situations: At the top of a hill, at the bottom of a hill, in a loop, and in a turn. Students may be given a paper drawing of a roller coaster, video of a real rollercoaster, or a model roller coaster. Students will draw arrows to show different forces acting on roller coasters at different positions.	Bloom's	DOK
			2
		Scoring Rubric	
		☐ **Proficient**: All forces are correctly identified, including gravity, inertia, potential energy and kinetic energy. Forces are labeled using arrows in the correct direction. ☐ **Progressing**: Some forces are labeled accurately. Most arrows are correct. ☐ **Beginning**: Few forces are labeled or correct. Arrows are missing or in the wrong direction.	

Instructional Strategies			
All Students	SWD	ELs	Enrichment
	Accommodations	Emerging	
		Expanding	
	Modifications	Bridging	

Authentic Performance Task 2

Name:	Simulate a rollercoaster using computer simulation	Suggested Length	Days: 1-2 Mins/Day:

Performance Expectations / Standards Addressed

Priority Standards

NGSS	Science and Engineering Practice(s)
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. **PS3-2** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.	**Analyze and Interpret Data** **Develop and Use Models**

Disciplinary Core Idea(s)

PS3.A: Definitions of Energy
Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.

A system of objects may also contain stored (potential) energy, depending on their relative positions.

PS3.C: Relationship Between Energy and Forces
When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

Crosscutting Concept(s)

Systems and System Models

Supporting Standards

NGSS	CCSS Math	CCSS Literacy	NG ELD

Teaching and Learning Progression

Students will design a virtual roller coaster track using BrainPop's Coaster Creator (online). Students must record the kinetic and potential energy output of their design. Roller coaster track design must include hills and loops. Students will modify the design of their track to ensure the roller coaster complete the track and safely stop. Student must take screenshot and print their coaster scores.

Bloom's	DOK
	3

Scoring Rubric

☐ **Proficient**: Design includes all required components. Roller coasters complete the track

		and safely stop. Student able to explain changes of potential and kinetic energy throughout their track. ☐ **Progressing**: Design includes all required components. Roller coasters complete the track and safely stop. Students are NOT able to explain changes of potential and kinetic energy throughout their track. ☐ **Beginning**: Design does not include all components and does not complete the track and/or stop safely.

Instructional Strategies			
All Students	SWD	ELs	Enrichment
	Accommodations ***Modifications***	Emerging Expanding Bridging	

Authentic Performance Task 3

Name:	Building a functional model roller coaster	Suggested Length	Days: 5-8 Mins/Day:
	Priority Standards		
	NGSS	Science and Engineering Practice(s)	
Performance Expectations / Standards Addressed	**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.	**Analyze and Interpret Data** **Develop and Use Models**	
		Disciplinary Core Idea(s)	

	PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.	**PS3.A**: Definitions of Energy Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. A system of objects may also contain stored (potential) energy, depending on their relative positions. **PS3.C: Relationship Between Energy and Forces** When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.
		Crosscutting Concept(s) **Scale, Proportion, and Quantity (PS3-1)** **Systems and System Models (PS3-2)**

Supporting Standards			
NGSS	CCSS Math	CCSS Literacy	NG ELD

Teaching and Learning Progression	Students will work in groups to design and construct a roller coaster track system to demonstrate evidence of potential and kinetic energy of a moving object (marble, ball bearing, toy cars, etc.). Construction possibilities include: cardboard tubing, paperrollercoaster.com, premade tracks, pipe insulations. Track design must include hills, loops, and turns. The marble complete the track and must stay on the track the entire time.	Bloom's	DOK
			4
		Scoring Rubric	
		☐ **Proficient**: Design includes all required components. Roller coasters complete the tracks safely. Students are able to explain changes of potential and kinetic energy throughout their track. ☐ **Progressing**: Design includes all required components. Roller coasters complete the track safely. Students are NOT able to explain changes of potential	

	Students will measure length and height of their track. Student will record time and calculate average speed of their roller coaster. Students **may** design and build an electromagnet brake system to stop their coaster at the end of the tracks. Once the design of the coaster is finalized, students will test the track using another object with a different mass to record the effects on motion or speed.	and kinetic energy throughout their track. ☐ **Beginning**: Design does not include all components and does not complete the track safely.

Instructional Strategies			
All Students	SWD	ELs	Enrichment
	Accommodations	Emerging	
		Expanding	
	Modifications	Bridging	

Authentic Performance Task 4

Name:	Roller Coaster Publicity campaign	Suggested Length	Days: 3-5 Mins/Day:
Performance Expectations / Standards Addressed	Priority Standards		
	NGSS	Science and Engineering Practice(s)	
	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.	Obtain, Evaluate, and Communicate Information	
		Disciplinary Core Idea(s)	
		PS3.A: Definitions of Energy Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. **(MS-PS3-1)** A system of objects may also contain stored (potential) energy, depending on their relative positions. **(MS-PS3-2)**	

Teaching and Learning Progression

PS3.C: Relationship Between Energy and Forces
When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. **(MS-PS3-2)**

Crosscutting Concept(s)

Scale, Proportion, and Quantity (PS3-1)

Systems and System Models (PS3-2)

Supporting Standards

NGSS	CCSS Math	CCSS Literacy	NG ELD

Bloom's	DOK
	3

Design and create an advertising campaign for your coaster including a public advertisement, a news article or presentation, and an article for a professional journal.

Student will create advertising for their roller coaster model/design. Students will write two articles for different audience groups and create a poster. The articles and posters need to justify why their roller coaster design was successful.

Scoring Rubric

- ☐ **Proficient**: Final products accurately and appropriately address all required parts and different type of audiences. Students show understanding of how forces, kinetic energy, and potential energy relate to their roller coaster design.
- ☐ **Progressing**: Final products are mostly accurately and appropriately address all required parts and different type of audiences. Students have difficulty relating forces, kinetic energy, and potential energy to their roller coaster design.
- ☐ **Beginning**: Final products do not accurately and appropriately address all required parts and/or different types of audience. Students

		cannot relate forces, kinetic energy, and potential energy to their roller coaster design.

Instructional Strategies			
All Students	SWD	ELs	Enrichment
	Accommodations	Emerging	
		Expanding	
	Modifications	Bridging	

Engaging Scenario

Detailed Description (situation, challenge, role, audience, product or performance)
Students will create a presentation on the research, design, and data of their roller coaster track in the role of a beach front property developer. Their presentations will aim to educate and persuade potential customers why their track design is the safest and most exciting. Students must demonstrate how forces, mass, speed, potential energy, and kinetic energy affect their roller coaster. Students may also make a video (TedTalk), audio, or other digital forms to present.

Instructional Strategies			
All Students	SWD	ELs	Enrichment
	Accommodations	Emerging	
		Expanding	
	Modifications		

		Bridging	

Scoring Guide:

Advanced: Everything included in proficient plus: multiple digital components, ability to relate force, potential energy, and kinetic energy from their roller coaster to other real-life situation.

Proficient: Student presentation includes all the required parts and includes at least one digital component. Students are able to specifically cite how their roller coaster design relates to forces, mass, speed, potential energy, and kinetic energy. Students are able to communicate that a change in mass, speed, and/or height will cause change in force, potential energy, and kinetic energy.

Progressing: Student presentation includes most of the required parts and includes at least one digital component. Students show difficulty with citing how their roller coaster design relates to forces, mass, speed, potential energy, and kinetic energy. Students are not able to express that a change in mass, speed, and/or height will cause change in force, potential energy, and kinetic energy.

Beginning: Student presentation includes some of the required parts and does not include a digital component. Students cannot cite how their roller coaster design relates to forces, mass, speed, potential energy, and kinetic energy. Students are not able to express that a change in mass, speed, and/or height will cause change in force, potential energy, and kinetic energy.

Feedback to Curriculum Team Reflect on the teaching and learning process within this unit of study. What were some successes and challenges that might be helpful when refining this unit of study?		
	Successes	Challenges
Student Perspective		
Teacher Perspective		