3D Science Performance Assessment Tasks

MIDDLE SCHOOL

HUMAN LOOP TO LOOP

These materials were developed under a grant awarded by the Michigan Department of Education

Task Title	Human Loop to Loop

Standards Bundle Information
Performance Expectations (PEs) • **MS-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. • **MS-PS3-5:** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
Science and Engineering Practices (SEPs) **Developing and Using Models** • Students develop and/or modify a model to predict and/or describe phenomena. • Students develop and/or modify a model to show relationships both observed and unobserved about the phenomena. • Students develop and/or modify a model to generate data to test ideas about phenomena. **Engaging in Argument from Evidence** • Students construct, use, and/or present an oral and written argument 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. • Compare and critique two arguments and analyze how they are similar or different. • Receive critique about one's explanations and models by citing relevant evidence to elicit details and further explanations. • Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.
Cross-Cutting Concepts (CCCs) **Energy and Matter** • Students should be able to track the transfers of matter and energy within, into, or out of any system under study. • Different forms of energy-potential, kinetic, thermal, motion • Energy can be transferred through a system and is conserved.
Systems and Systems Models • Students systems may interact with other systems. Either as a subsystem or as a part of a larger system. • Models can be used to represent systems or interactions. • Models can be limited and only present certain aspects of the system.

Disciplinary Core Ideas (DCIs)

- Energy can be potential or kinetic within a system and is always conserved or transferred between objects.
- Energy must be provided to exert a force and the amount of energy needed depends on type of matter, sample size, and environment.
- Energy always flows from hotter to colder through conduction, convection, and radiation.

CCSS ELA:

- SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)
- 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-PS3-5)
- WHST.6-8.1 Write arguments focused on discipline content. (MS-PS3-5)

CCSS Mathematics

- MP.2 Reason abstractly and quantitatively. (MS-PS3-5)
- 6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-5)
- 7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS3-5)
- 8.F.A.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-5)

Overview / Introduction of the Assessment Task:

In this task, students make an oral or written argument to support or refute claims based on relevant criteria and constraints of the models data. Energy must be provided to the system or subsystem and is dependent upon interactions such as type of matter, size of the object, and the environment).

Teacher Background

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.] [*Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.*]

Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [*Assessment Boundary: Assessment does not include calculations of energy.*]

Information for Classroom Use
Connections to Instruction: This task would come at the end of a unit on energy. Students need basic prior knowledge about forces, particularly gravity and friction.
Approximate Duration for the Summative Task: (all components) Approximately one class period.
Assumptions: The 3DSPA was designed to assess students' ability to perform the task by applying previous knowledge learned to the new phenomena in the performance assessment without having been exposed to this specific phenomena in advance. Students should have prior experience with modeling and writing arguments.
Materials Needed: Computers with internet access, tennis balls, meter sticks, marbles, insulation tube
Supplementary Resources: Students build their own small-scale model roller coasters, and then analyze them using physics principles learned in the associated lesson. They examine conversions between kinetic and potential energy and frictional effects to design roller coasters that are completely driven by gravity. A class competition using different models to represent different passenger loads and determine the most innovative and safe roller coasters. Models used for the oral/written argument will need data to support/refute student claims. http://www.discoveryeducation.com/teachers/free-lesson-plans/the-ultimate-roller-coaster-contest.cfm[1] https://www.teachengineering.org/activities/view/duk_rollercoaster_music_act[2]

Learning Performances
I can develop and/or modify a model to show how potential and kinetic energy are transferred and conserved within a system, or subsystem. Energy must flow within a system or subsystem from hotter to colder either through conduction, convection or radiation. I can develop and/or modify a model to show how energy exerts force within a system or subsystem. I can develop and/or modify a model to show how the amount of energy needed depends on the type of matter, sample size, and environment within a system or subsystem. I can develop and/or modify a model to generate data and test ideas on potential and kinetic energy within a system, or subsystem. I can construct and use an argument supported by evidence to explain potential and kinetic energy within a system, or subsystem.

[1] "The Ultimate Roller Coaster Contest | Free Lesson Plans | Teachers ..." 2011. 4 Aug. 2016 <http://www.discoveryeducation.com/teachers/free-lesson-plans/the-ultimate-roller-coaster-contest.cfm>

[2] "Building Roller Coasters - Activity - www.teachengineering.org." 2016. 4 Aug. 2016 <https://www.teachengineering.org/activities/view/duk_rollercoaster_music_act>

I can compare and critique two arguments using evidence on potential and kinetic energy within a system or subsystem and explain how they are similar and different.

I can use evidence and scientific reasoning to support or refute an explanation on energy transfer within a system or subsystem.

I can make an oral or written argument to support or refute claims based on relevant criteria and constraints of the model that energy must be provided depending on the type of matter, size of the object and the environment in the system or subsystem.

Performance Assessments

<table>
<tr><th colspan="3">Student Performances</th></tr>
<tr><td rowspan="4">Formative Assessment Task 1</td><td>Learning Performance:

Students construct, use, and/or present a written argument 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.</td><td rowspan="4">Expected Duration:

One class period:</td></tr>
<tr><td>Description: Argument Task

What is energy?

What is meant by conservation of energy?

How is energy transferred between objects or systems?

Tennis ball lesson. Students will answer the question “How does the height from which a ball is dropped affect how high a ball bounces?”</td></tr>
<tr><td>Directions: Students analyze and interpret presented data table.</td></tr>
<tr><td>Scoring / Teacher Look-For’s: Teacher may need to scaffold predictions by making sure students look at average results for 100 cm and 50 cm. Predicted value should lie between the two averages.

1. Construct a claim about the phenomenon.
2. Identify evidence that supports the claim.
3. Articulate the scientific principles that connect each piece of evidence to the claim.
Option 1: Data Table (without data)

Option 2: Data Table (with data)

https://docs.google.com/document/d/1ElW6nvDWBm4kExyawdYQWUvAcG4dROK4Dq_Zws5Iggg/edit?usp=sharing</td></tr>
<tr><td rowspan="2">Formative Assessment Task 2</td><td>Learning Performance: I can develop and/or modify a model to show how the amount of energy needed depends on the type of matter, sample size, and environment within a system or subsystem.</td><td rowspan="2">Expected Duration:

One class</td></tr>
<tr><td>Description: Modeling task</td></tr>
</table>

	Question: How can I design a thrilling roller coaster that will safely complete the route? http://www.learner.org/interactives/parkphysics/coaster.html[3] https://docs.google.com/document/d/1gKUFfWp5V07qgLwPNuwgfQ_xRDr0D_E2qHpzerX-5EQ/edit?usp=sharing	
	Directions: Students construct 2 different roller coasters using the variables presented in the simulation. 1. Compare the 2 models to identify both common and unique components, relationships, and mechanisms. 2. Analyze collected data on both models. Explain how the relevant scientific ideas are taken into account within best design.	
Formative Assessment Task 3	**Learning Performance:** I can use evidence and scientific reasoning to support or refute an explanation on energy transfer within a system or subsystem. **What is meant by conservation of energy?** **How is energy transferred between objects or systems?** I can compare and critique two arguments using evidence on potential and kinetic energy within a system or subsystem and explain how they are similar and different.	**Expected Duration:** One class period
	Description: Models, construct explanations https://www.teachengineering.org/activities/view/duk_rollercoaster_music_act	
	Directions: Students are to construct a model of a roller coaster that will allow the collection of empirical data to be used in the presentation of safe roller coaster with a loop in its model. Students should include minimum three pieces of evidence from roller coaster model. A completed simulation that travels a course with a loop safely. Students summarize roller coaster Develop a written or oral argument to support or refute a student's design based on the data received from a student's model of a roller coaster.	
	Description (Phenomena, Scenario, Task):	

[3] "Amusement Park Physics -- Roller Coaster - Annenberg Learner." 4 Aug. 2016 <http://www.learner.org/exhibits/parkphysics/coaster.html>

	Students will use data collected from roller coaster models to compare and contrast who has the most thrilling and safest roller coaster design using evidence and write C-E-R to support or refute an explanation of energy transfer within roller coaster system.	
	Directions: Teacher and students return to summary table to answer four questions. A Gotta have checklist is created from which explanations can be written using evidence. Rubric for claim-evidence-reasoning[4] Claim-Evidence-Reasoning worksheet Have students complete a diagram noting forces and interactions of their roller coaster design. Next students complete venn diagram noting similarities and differences between two other roller coaster designs. Lastly, students write C-E-R explanations of observed phenomena to support or refute best roller coaster design.	
	Scoring / Teacher Look-For's: Students should have a minimum of three pieces of evidence and scientific reasoning to support claim. http://discoverykids.com/games/build-a-coaster/[5]	
Final Task:	**Learning Performance** Question: What components allow for safe operation of a roller coaster with the most thrills? Phenomena: roller coaster simulation Students can identify potential and kinetic energy and gravity within the roller coaster simulation. Teacher should encourage students to include observable and unobservable features in models. Any misconceptions and additional student questions can be added to the whole class consensus model.	
	Phenomena: https://commons.wikimedia.org/wiki/Roller_coaster#Video	Expected Duration:

[4] "Claim Evidence Reasoning." 2013. 5 Aug. 2016 <https://www.nsta.org/elementaryschool/connections/201104ClaimsEvidenceRubric.pdf>

[5] "Build a Coaster | Discovery Kids." 2014. 4 Aug. 2016 <http://discoverykids.com/games/build-a-coaster/>

	https://commons.wikimedia.org/wiki/Roller_coaster#/media/File:Organizaci%C3%B3n_2_trenes_en_monta%C3%B1a_rusa.gif		One class period
	Goal: Students will argue for energy interactions within the human loop to loop and relate it to their roller coaster design and safety considerations.	**Role:** Design engineer	
	Audience: Amusement park client	**Situation:** To present a written or oral argument for the safest and most thrilling design of a roller coaster that completes a course.	
	Product / Performance: Argument writing or oral presentation Web pages for roller coaster simulation. Discussion on how to represent forces, potential energy, kinetic energy, friction, energy transfer points, and acceleration should occur.		
	Student Directions: **Teacher Directions:** Model C-E-R framework. Students should have at least three pieces of evidence and scientific reasoning to support claim. Argument organizer[6] Argument writing rubric[7] Argument oral rubric[8]		

[6] "Teaching the Essentials - Jim Burke." 2008. 5 Aug. 2016 <http://www.englishcompanion.com/pdfDocs/BurkeHOutsFullWorkshop.pdf>

[7] "4-Point Argumentative Performance Task Writing Rubric - SBAC Portal." 2013. 5 Aug. 2016 <http://sbac.portal.airast.org/wp-content/uploads/2013/09/PerformanceTaskWritingRubric_Argumentative.pdf>

[8] "iRubric: Argumentative Oral Presentation rubric - B79833: RCampus." 2012. 5 Aug. 2016 <http://www.rcampus.com/rubricshowc.cfm?code=B79833&sp=true>

CheckBric

Student Name _____

Teacher Name _____

Learning Performance: I can make an oral or written argument to support or refute claims based on relevant criteria and constraints of the model that energy must be provided depending on the type of matter, size of the object and the environment in the system or subsystem.					**Comments**
Insert Evidence Statements below:					
Can use the types of energy interactions and forces in their arguments 1. Potential 2. Kinetic 3. Forces (friction, gravity) 4. Conservation of energy	**1**	**2**	**3**	**4**	
Can argue for or against relevant criteria and constraints of a model for a system **Criteria:** Model was appropriate type and student understands limitations.	**1**	**2**	**3**	**4**	
Can give a written or oral argument to support or refute a claim with evidence.	**1**	**2**	**3**	**4**	

4 Exemplary	Work at this level is of exceptional quality. It is both thorough and accurate. It exceeds the standard. It shows a sophisticated application of knowledge and skills.
3 Proficient	Work at this level meets the standard. It is acceptable work that demonstrates application of essential knowledge and skills. Minor errors or omissions do not detract from the overall quality.
2 Developing	Work at this level does not meet the standard. It shows basic, but inconsistent application of knowledge and skills. Minor errors or omissions detract from the overall quality. Your work needs further development.
1 Emerging	Work at this level shows a partial application of knowledge and skills. It is superficial (lacks depth), fragmented or incomplete and needs considerable development. Your work contains errors or omissions.

Item Production Information

Copyrighted Material and Sources

"The Ultimate Roller Coaster Contest | Free Lesson Plans | Teachers ..." 2011. 4 Aug. 2016 <http://www.discoveryeducation.com/teachers/free-lesson-plans/the-ultimate-roller-coaster-contest.cfm>

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"Teaching the Essentials - Jim Burke." 2008. 5 Aug. 2016 <http://www.englishcompanion.com/pdfDocs/BurkeHOutsFullWorkshop.pdf>

“4-Point Argumentative Performance Task Writing Rubric - SBAC Portal." 2013. 5 Aug. 2016 <http://sbac.portal.airast.org/wp-content/uploads/2013/09/PerformanceTaskWritingRubric_Argumentative.pdf>

"iRubric: Argumentative Oral Presentation rubric - B79833: RCampus." 2012. 5 Aug. 2016 <http://www.rcampus.com/rubricshowc.cfm?code=B79833&sp=true>