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| **Lesson Title : Energy Transformations** | **Unit #:****1** | **Lesson #:****2** | **Activity #:****3** |
| **Activity Title: Rollercoaster Mania** |

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| **Estimated Lesson Duration:** | **7 days** |
| **Estimated Activity Duration:** | **5 days** |

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| **Setting:** |  |

Classroom

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| **Activity Objectives:** |

To incorporate visual and manipulative activities related to transformation of potential to kinetic energy through an open ended challenge with constraints and instruct on the use of the kinetic and potential energy equations to calculate energy.

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| **Activity Guiding Questions:** |

How can potential energy be converted into kinetic movement through twists and turns as well as gravity?

How can potential and kinetic energy be calculated?

| **Next Generation Science Standards (NGSS)**  |
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| **Science and Engineering Practices (Check all that apply)**  | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☒ Patterns |
| ☒ Developing and using models | ☒ Cause and effect |
| ☒ Planning and carrying out investigations | ☒ Scale, proportion, and quantity |
| ☒ Analyzing and interpreting data | ☒ Systems and system models |
| ☒ Using mathematics and computational thinking | ☒ Energy and matter: Flows, cycles, and conservation |
| ☒ Constructing explanations (for science) and designing solutions (for engineering) | ☒ Structure and function.  |
| ☒ Engaging in argument from evidence | ☒ Stability and change.  |
| ☒ Obtaining, evaluating, and communicating information  |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☒ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☒ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☒ Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** |
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| **Standards for Mathematical Practice (Check all that apply)** |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

**Ohio’s New Learning Standards: Science Standards: Physical Science**

• Conservation of energy

• Quantifying kinetic energy

• Quantifying gravitational potential energy

• Energy is relative

• Transfer and transformation of energy (including work)

**Next Generation Science Standards**

PS3.A: Definitions of Energy

PS3.B: Conservation of Energy and Energy Transfer

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

PE KE Calculation powerpoint

Potential Energy Worksheet

Kinetic Energy Worksheet

Potential and Kinetic Energy Worksheet

Potential and Kinetic Energy Worksheet - 2

Softball toss paper.

Piping insulation tubing.

Small marbles.

Masking tape.

Other materials around the room may be used as needed.

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| **Teacher Advance Preparation:** |

The pipe insulation for the rollercoaster mania challenge will need to be cut in half lengthwise to create the rollercoaster track. Teacher must also select an area in which the student may create and make their tracks. The classroom may be a suitable location for the activity.

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| **Activity Procedures:** |

**Day 1:**

* Review powerpoint for performing calculations using potential and kinetic energy formula.
* Perform practice examples in class for potential energy calculations then provide example problems using the following worksheet:
	+ Potential Energy
* Perform practice examples in class for kinetic energy calculations then provide example problems using the following worksheet:
	+ Kinetic Energy

Day 2

* Review Completed Potential Energy and Kinetic Energy Worksheets from Day 1.
* Handout homework practice problems using mixed problem set of potential and kinetic energy. These will require the student to first identify which equation must be used in the scenario and then complete the calculations.
	+ Potential and Kinetic Energy
* Provide final worksheet combining problems which may use either Kinetic or Potential energy formulas.
	+ Potential and Kinetic Energy – 2

Day 3:

* Review Potential and Kinetic Energy – 2 worksheets identified in the items above
* Hand out Softball Toss exercise which requires the students to assess a simulated situation. Complete calculations for potential and kinetic energy and graph each in relationship to speed and height. The students will then assessed the graphs and identify the relationship of potential and kinetic energy. This will be turned in and assessed.

**Day 4:**

* Assessment on performing calculations on potential and kinetic energy.
* Handout the Rollercoaster mini-challenge. Explain the challenge and related constraints. Students will have the first day to test and experiment with their tracks. On the second day the students will finalize their tracks and have them tested. They will also be required to perform calculations and relate potential and kinetic energy to the movement of the marble down their track.

**Day 5:**

* Demonstrate and assess Rollercoasters.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

Will be performed using homework and in class discussion during review of the homework. Evaluation of completed tracks will also be used in the assessment.

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

Summative Assessments will performed through a quiz to be administered on the last day of the activity. Evaluation will also occur through the assessment of written response to questions on the Rollercoaster Mania, mini-challenge.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.Refer to Activity Template for details. |

Additional help may be required to assist those that are challenged performing mathematical computations. The Rollercoaster Mania mini-challenge provides numerous options for construction.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

Instructional time and practice time for the potential and kinetic energy calculations was impacted by development of the Rube Goldberg devices, so I attempted to expedite the process by having the students perform all calculations as homework outside of the classroom and then to assess their work to determine mastery. Typically I would have them perform some of the work in the classroom to provide them with support. When evaluating their work, I found that few of them had a good understanding of the calculations. As they worked on their devices I returned their homework and provided individual help. I also decided that we would need to revisit the calculations after completion of the devices. Also during this time, I put off having an assessment on the calculations for the same reason.

It was also very evident that I would need to spend more time with the calculations when they turn in their Softball Toss activity. They struggled with putting together the use of the formulas with the context of the ball being tossed in the air and the idea of energy conservation. I returned these to individuals and gave them further instruction to help them address problems they had with the activity. Like the other worksheets, by not providing them time to work the activity in class, they struggled with the activity. Another item which became clearer was that the students did a very poor job of reading the instructions. When the instructions were pointed out, most of the students had an “aha” moment.

Again, I had to come back to the calculations portion of the lesson upon completion of the devices as a result of these observations and did not feel that performance of a summative assessments was prudent based on the students understanding at the time. When I came back to this after the lesson, a large percentage of them were more successful as indicated on the post-Test results.

The rollercoaster challenge was very engaging. I spent 2 days on the activity and included some of the engineering aspects including restraints such as cost and design requirements. Many created very unique coasters or were extremely streamline in their design. However, I felt that 2 days was too much time to spend, and because they were designing and refining to the end or the second day, most were unable to get to the questions which were designed to cause them to performed calculations and assessments on the track to qualitatively demonstrate the energy transformations. I believe the longer time I would give them, the more time they would take to design their coasters. A better adjustment for this would have been to have them design and demonstrate on the first day, they reconstruct and measure on the next. I would also consider placing this activity closer to the beginning and removing the calculations portion. The idea behind that would be for them to get additional ideas regarding design for their Rube Goldberg devices.