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| **Name: Larry Honigford** | **Contact Info:** [**Larry.honigford@lakotaonline.com**](mailto:Larry.honigford@lakotaonline.com) | **Date: 1/26 – 1/27/16** |

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| **Lesson Title :** | **Unit #:**  **1** | **Lesson #:**  **2** | **Activity #:**  **4** |
| **Activity Title: Rube Goldberg Challenge** |

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| **Estimated Lesson Duration:** | **7 days** |
| **Estimated Activity Duration:** | **2 days** |

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| **Setting:** |  |

Classroom

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| **Activity Objectives:** |

Model the Law of Conservation of Energy

Describe the relationship to energy transformation in a system.

Create and refine models defining scientific principles.

Communicate and describe models relaying scientific principles.

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| **Activity Guiding Questions:** |

What is meant by the conservation of energy?

How does energy transform from one kind to another?

How can energy be quantified within a system to demonstrate conservation of energy?

| **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) |

Materials to build the Rube Goldberg devices will be provided by the student. Some miscellaneous materials may be made available to students in the classroom.

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| **Teacher Advance Preparation:** |

Areas must be identify in which the students may store and test their devices.

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| **Activity Procedures:** |

* Students will need to bring in the materials they have selected to use in their Rube Goldberg Device.
* On the first day they will be allowed to set up, test and modify their device as needed.
* On the second day they will be tested and evaluated by the instructor. Students must present their device and describe how it will work prior to its final test in front of the instructor.

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

Formative assessments will be provided during in class student work time. A checkpoint will be performed to assure student progress as follows.

Day 3 Idea selected.

Day 5 Initial drawings and material list

Day 8 Update draws and materials acquisition

Day 11 Final drawings and implementation/testing

**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.

Completion of the portfolio for the Rube Goldberg Challenge and completion of questions from the Rube Goldberg Challenge packet.

Documentation to be kept in portfolio:

\_\_\_\_\_\_\_ **Brainstorming:** List of Initial Brainstorming session with ideas. (Gathering Information)

\_\_\_\_\_\_\_ **Selection:** Short list of ideas you will include in your device and brief explanation as to why you selected them. (this may consist of multiple documents including scratch outs).

\_\_\_\_\_\_\_ **Drawings:** All drawings you make should be included in the portfolio, including drawings which are no longer to be used (indicate on the drawing that is no longer being used). Note: It is OK to change what you originally decided upon.

\_\_\_\_\_\_\_ **Journal entries:** Provide short journal entries describing what you did each day regarding your device. Place a date before each entry. This will include any test, material received, changes, results, decisions, and any other critical items related to your device.

\_\_\_\_\_\_\_ **Report:** Description of your final device along with final drawing. Must include how it met the criteria. The final drawing should be very clear.

\_\_\_\_\_\_\_ **Presentation:** You must present your device to the instructor. You must include description of how your device will work and how the energy is transferred.

\_\_\_\_\_\_\_ Packet Completion along with questions and description of Energy Transformations.

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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. |

The presentation and creation of the challenge allowed for many approaches and learning styles based on its limited constraints and ability to develop multiple correct devices.

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

The final presentation of the devices was chaotic but was very fun. Due to the continued work that the students were performing to finish their devices, I decided not to do a full class presentation. I felt the time was better spent for the students to work on their devices. The originality of many of the devices was very exciting to see and it was wonderful to see their devices successful and the look on their faces when the device did work. Some groups were unable to successfully demonstrate their device, as either one step or another failed to work. Overall, they success rate for completed and successfully demonstrated devices was over 80%. About 10 % had devices that were completed but could not successfully be demonstrated due to one step in the process. The remaining 10 % failed to produce a complete device. Of these 10% most groups did not spend time testing their device in class well and simply were not prepared.

Answering the questions to quantify potential and kinetic energies was problematic due to the complexity of the students design. Support had to be provided to assist the students with how to focus on the calculations. In reality, the questions could not be answered as written because their designs had far too many complex energy transfers that using kinetic and potential energy calculations was too simplistic. I took the approach to use their highest position and the object at that highest position to calculate the potential energy, then assume all potential is converted to kinetic, and use the mass of the object to calculate velocity.

Evaluation of the portfolios was new to me and I was not sure what to expect. For the most part individuals provided the information needed. During the project I provided feedback on their portfolios so that they could assess their progress and address any missing items. I needed to provide better requirements for the reports. I provided verbal requirements to the class telling them to provide a description of the device and how they came to their final design. These reports varied greatly including anything from type written well thought out reports to those with a few sentences. If I were to do this again, I would have just used a question and response page for the items I was looking for.