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| **Lesson Title :** Storing Energy is Necessary to Control When It’s Used | **Unit #:**  **1** | **Lesson #:**  **1** | **Activity #:**  **2** |
| **Activity Title:** Introduce the Challenge and then use KWL to help students formulate “Guiding Questions.” |

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| **Estimated Lesson Duration:** | 3 Days |
| **Estimated Activity Duration:** | 1-2 Day |

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| **Setting:** | Room 1556 |

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| **Activity Objectives:** |

**The Challenge:** Students will build an electric toy car and, more importantly, one or more energy storage devices, so that it can complete an “Amazing Race,” as a set of challenges, including race and pull a load, in a fixed amount of time.

Students will self-assess what they know about energy storage. Students will generate a list of guiding questions about Challenge.

Constraints they will need to hit:

\* All have the same car kit and can only use the parts provided (with approved exceptions).

\* All cars will have recharging as part of their testing time.

\* Can work with limited variety of electricity storage devices as power supply.

\* Must complete tasks between start of quarter and exams.

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| **Activity Guiding Questions** (sample of possible student-generated Guiding Questions)**:** |

1. Can we modify the car (Variety of questions)?
2. Can we supply our own batteries/storage devices?
3. Are we limited to one battery/storage device at a time?
4. Does the car have to carry the storage device?
5. What is the resistance of the car’s circuits?
6. How much energy can each storage device store?
7. What is the power output of each storage device?
8. How long does it take to charge each storage device?

How much energy does each task require?

| **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 Learning Standards for Science (OLS)** |
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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)** |

| **Ohio’s Learning Standards for Math (OLS) and/or**  **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, OLS and/or CCSS):** |

From *Course Outcomes for Regular Physics*, November 19, 2015.

4. Defend the use of 1st principles, assumptions, formulae, and graphs to accurately predict the outcome of a described physical phenomenon.

8. Analyze the current and future behavior of physical systems using the idea of kinetic and potential energy as well as the laws of conservation of energy and conservation of momentum.

10. Calculate the current, voltage and/or resistance in an electrical circuit.

11. Design and build electrical circuits using a single power source and resistors.

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

Paper for KWL or use of Canvas discussion board

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| **Teacher Advance Preparation:** |

Set up plan for Challenge and Canvas discussion board.

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| **Activity Procedures:** |

1. Ask students to write down everything they know about electrical energy storage.
2. Ask them to write down what they would need to know if they were to make their own device to store electricity.
3. Submit the Challenge to them… possibly with modifications to fit student-generated ideas, specifications, or requests. The constraints of the Amazing Race must use a challenging amount of energy and that means they need to be fashioned to meet available charge-storing devices.
4. Ask them to write down what they need to learn to successfully fulfil the challenge… specify that they should write these in question form. These should be similar to the **Activity Guiding Questions** above.

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

Make certain students are participating by having them think-pair-share their KWL and group share their Guiding Questions.

**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.

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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. |

All students can participate on this assignment at their level. Grouping student in pairs based on their extroversion level may be beneficial to make certain all voices are heard.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson.  This worked approximately as well as expected. The more studious had many more and more detailed questions. Some had weaker questions. However, having them share to each other and to their groups really built up a decent set of working questions.  Even so, as this was early on, they did NOT think about calculation and formulae, so I had to steer them into gathering information on calculating the energy stored in a batter, in a capacitor, and the rate at which the energy was placed onto the devices using a charging system. |