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**Educational Epiphany ™**

Districtwide PLC Protocol for **Science**

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| Teacher/Teacher Team: Hogan |
| Grade: Physical Science 9/25-9/29 |
| Date: 10 (50 - 55 minute class) or 6 (90 minute class) |

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| **#** | **Planning Question** | **Teacher/Teacher Team Response** | |
| 1 | Which **state standard** is your lesson progression addressing? | **PSCI.PS3.3** Design, build, and refine a device within design constraints that as a series of simple machines to transfer energy and/or do mechanical work.  **PSCI.PS3.4** Collect data and present your findings regarding the law of conservation of energy and the efficiency, mechanical advantage, and power of the refined device. | |
| 2 | What **scientific concepts or phenomena** are embedded in the state standard? | **Concept(s):** Work & Energy Transfer; Work, Power, & Mechanical Advantage  **Phenomenon**: (See Curriculum Map)  A Rube Goldberg machine displays several key principles, including conservation of energy, conservation of momentum, and ideas about vital forces of an engineered device. | |
| 3 | What teacher **knowledge, reminders, and misconceptions** are assumed in the standard? | **PSCI.PS3.3**  **Knowledge:**  Students design, build, and refine a device within design constraints. The device could be a Rube Goldberg machine with the following as examples of constraints: Require that their Rube Goldberg machine contain a certain number of steps; Ensure it carries out a specific task; and make certain it remains within a strict time frame. Students develop a plan for the device in which they do the following: Identify what scientific principles provide the basis for the energy conversion design; Identify the forms of energy that will be converted from one form to another in the designed system; Identify losses of energy by the design system to the surrounding environment; Describe the scientific rationale for choices of materials and structure of the device, including how student-generated evidence influenced the design; and Describe that this device is an example of how the application of scientific knowledge and engineering design can increase benefits for modern civilization while decreasing costs and risk.  **PSCI.PS3.3**  **Reminders:**  Emphasis is on both qualitative and quantitative evaluations of devices.  **PSCI.PS3.4**  **Knowledge & Reminders:**  An understanding of conservation of energy should lead to conversations about the efficiency of a device. A well-designed device should utilize as much of the available energy as possible for the desired task. Other energy will be converted to forms, such as heat and noise, which may not be immediately useful based on the intended use for the device. Students can investigate kinetic, potential, and total energy within a closed system using various phenomena for example the Rube Goldberg Machine.  **Misconceptions:**   * Increasing work – students might think that machines decrease the amount of work necessary to complete a task. In fact, machines always increase the amount of work necessary to complete a task. No machine is 100 percent efficient. * Efficiency and Mechanical Advantage - Students often confuse efficiency and mechanical advantage. Both are output to input ratios. Efficiency is a ratio of output work to input work and mechanical advantage is a ratio of output force to input force. Efficiency of a machine must always be less than 1 and mechanical advantage of a machine can be less than 1, equal to 1, or greater than 1. | |
| 4 | What **objective(s)** must be taught? In what order? Why? | 1. **SWBAT** identify and describe six types of simple machines **IOT** compare and contrast them in terms of mechanical advantage and practical use. 2. **SWBAT** identify elements of simple machines in compound machines **IOT** analyze their mechanical advantage and efficiency. 3. **SWBAT** use engineering design constraints **IOT** design, build, and refine a device that has a series of simple machines to transfer energy and/or do mechanical work. 4. **SWBAT** calculate the mechanical advantage of moving an object using a simple machine **IOT** compare and contrast characteristics of a simple machine. | 1. **SWBAT** research and collect data on the law of conservation of energy, efficiency, mechanical advantage, and power of a refined device **IOT** present findings.   (The performance-based objectives are listed in the order in which they are to be taught to address the standard's depth.) |
| 5 | What is your **resource plan for each of the 5 Es** of inquiry-based science instruction?   1. Engage 2. Explore 3. Explain 4. Elaborate 5. Evaluate | **Engage** Tie to Prior Knowledge, Student Work, TE p. 106 • Tie to Prior Knowledge, Vocabulary Analogy, TE p. 106  **Explore** Activity: Analyzing Forces, TE p. 108 • Activity: Kinesthetic, TE p. 111 • Activity: Changing Force Direction, TE p. 111 • Lab: Mechanical Advantage and Efficiency, p. 113  **Explain** EXAMPLE Problem 1: PRACTICE Problems, p. 107 • EXAMPLE Problem 3: PRACTICE Problems pg. 112 • BrainPOP: Pulleys • Visual Learning: Figure 5, TE p. 111 • Additional Practice Problems: Chapter 4, p. 801- 802  **Elaborate** Science Journal: Everyday Work, TE p. 108  **Evaluate Section 1 Review: p. 112** | |
| 5B | What is your resource plan for **blended learning?** | **SUGGESTED OPPORTUNITIES FOR TECHNOLOGY**  Log into McGraw-Hill connectED platform via Clever and Canvas before accessing identified hyperlinked materials.   * BrainPOP: [Pulleys](https://connected.mcgraw-hill.com/media/repository/protected_content/COMPOUND/50000027/20/21/index.html?mghCourseID=MPF89YHKZK8ZBF6PR4OTWJKCE1) (McGraw-Hill) * Animation: [Benefits of Machines](https://connected.mcgraw-hill.com/c2j/resourceLibrarySearch.do?bookId=MPF89YHKZK8ZBF6PR4OTWJKCE1&libraryId=PBGFQMD795WLCM11CKTRL9TRP4&chapterId=5SJY7CW19FLM53ZW4XMYFL9T2O&lessonId=PBGFQMD795WLCM11CKTRL9TRP4) (McGraw-Hill) * Video: [Amazing Rube Goldberg Machines](https://thewonderofscience.com/phenomenon/2018/7/8/amazing-rube-goldberg-machines) | |
| 6 | What **academic language** must be taught **before and after the explain phase**? How will the academic language be **taught and assessed**? | **Academic Language:**  compare: - note similarities  contrast: to note differences  describe: to give account in words (of someone or something), including all the relevant characteristics, qualities, or events  device: an instrumentality invented for a particular purpose  efficiency: – ratio of the output work done by the machine to the input work done on the machine, expressed as a percentage​  energy: the ability to cause change, measured in joules ​  identify: recognize and name  Law of Conservation of Energy: states that energy cannot be created or destroyed​  mechanical advantage: ratio of the output force exerted by a machine to the input force applied to the machine  power: rate at which energy is converted​  practical: guided by practical experience and observation rather than theory  refine: improve or perfect by pruning or polishing​  research: a search for knowledge​  simple machine: machine that does work with only one movement  **Taught:**  **Assessed:** | |
| 7 | What is your plan to ensure that assessment of instruction on this standard is not solely characterized by remembering or **regurgitating factual information**? | Experiment with selected simple machines to discover the relationship between force and distance. • Solve problems related to force, work, and power. • Identify various types of simple machines. • Recognize the simple machines found in a compound machine. • Investigate the factors that determine the speed of an object rolling down a ramp. • Solve application problems related to mechanical advantage and the efficiency of simple machines, given appropriate equations (MA=FO/FI and Eff=WO/WI). | |
| 8 | What **literacy concept** can be intertwined with instruction on this scientific concept or phenomenon? | Making sure student can use the formulas for velocity, speed, momentum and acceleration. | |
| 9 | How will instruction be impacted by the Cross Cutting Concepts and the Science & Engineering Practices? | **Crosscutting Concept(s)**:  Energy and Matter   * Students demonstrate and explain conservation of mass and energy in systems including systems with inputs and outputs. * Students explain the conservation of energy by discussing transfer mechanisms between objects or fields as well as into or out of a system.   Systems and System Models   * Students create and manipulate a variety of different models: physical, mathematical, computational.   **Science and Engineering Practice(s):**  Developing and using models   * Students can create models for interactions of two separate systems. * Student models are functioning prototypes and able to generate data useful for both computation and problem solving.   Construct an explanation and designing solutions   * Students evaluate complex designed systems and select the optimal solution-based tests they design and conduct, taking into account a prioritization of multiple constraints.   Obtaining, Evaluating, and Communicating Information   * Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). | |