**Why Modeling Matters**

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| **Title: Modeling the Behavior of a Confused Can**  **Estimated Time: 1-2 Periods** | |
| **Core Ideas (GSE Standards):**  **Multiple standards at each grade level include the requirement of developing and using models to describe and explain various phenomena. For example,**  **S5L1a.**  Develop a model that illustrates how animals are sorted into groups (vertebrate and invertebrate) and how vertebrates are sorted into groups (fish, amphibians, reptiles, bird, and mammal) using data from multiple sources.  **S8P1b.** Develop and use models to describe the movement of particles in solids, liquids, gases, and plasma states when thermal energy is added or removed.  **SP4a.**  Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy. | |
| **Science and Engineering Practices:**  **Asking Questions and Defining Problems:**   |  | | --- | | Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. |   **Developing and Using Models**  Use and/or develop a model of simple systems with uncertain and less predictable factors. | **Crosscutting Concepts**  **Models and System Models**  Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.  Models are limited in that they only represent certain aspects of the system under study.  **Energy and Matter: Flows, Cycles, & Conservation**  Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. |
| **Authentic Scenario**  In this lesson, students explore the importance of constructing and using models in science. By constructing their own simple models, students see firsthand how useful and beneficial it is to construct models as tools for representing their ideas and explanations. These models can include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. In this lesson, student observe the phenomena of a rolling can behaving in an unusual and unexpected manner. After observing the strange behavior, they are asked to design and construct and a model that can imitate the behavior of the can.  This simple example also helps students to understand how important models can be when scientists are limited in their ability to see the internal workings of a systems such as what happens inside a cell or what happens to particles during a chemical reaction. As a result, we often build models to help us explain how these systems might actually function. While they are based on the indirect and limited evidence that is currently available, they can be powerful tools for building our understanding of the world. In this lesson, your task is to build a model that replicates the unusual behavior of the Confused Can.  **Guiding Question**  How can models be used to help us understand the internal structure and function of something we cannot see directly? | |

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| **5E Stage** | **Student Activities**  How will students engage actively in the three dimensions throughout the lesson? | **Teacher Activities**  How will the teacher facilitate and monitor student learning throughout the lesson? |
| **Engage** | * Students brainstorm why models are vitally important in science * Students predict what will happen when you roll the can away from you and why. * Students observe closely and record their observations. * Students generate questions based on their observations of the can. * Students to brainstorm possible explanations for the unexpected behavior of the can. | * Facilitate student brainstorming and highlight modeling if needed * Roll the can across a long table or the floor and allow students to observe. Repeat * Encourage students to generate as many questions as possible based on their observation of the can. |
| **Explore** | **Challenge:**  In this challenge, your job is to diagram and then create a working physical model of the Confused Can. The can should replicate the behavior of the confused can as closely as possible.  **Imagine/Brainstorm-**  **Criteria:**  1. The cannister must be constructed from the approved materials in the bag  2. Not all of the materials need to be used in the construction  3. The rubber band should be used to convert potential energy into kinetic energy.  4. The canister should return to as close as possible to the original position.  **Constraints:**  1. Use only the materials provided  2. Complete the challenge in the time allotted  **Plan/Design-**  Each student presents their ideas to their team. Student teams collaborate to develop a final design plan. Students draw and label their final design plan.  Groups can design their Confused Can in their journals or using a drawing app. As an alternative, they can make a video of their final product and narrate what they did.  **Create/Test-**  Student teams build their model canister according to their design plan. Students test their design measuring how closely the canister returns to its original position. | Have students individually create a diagram to show a possible working model of the Confused Can. Students should draw, label, and briefly explain their design.  Facilitate student presentations of their ideas to their team members.  Ask/answer appropriate questions to guide student work as they build and test their models. |
| **Explain** | Students explain how their model can be used to describe the behavior of the Confused Can.  Students explain why the process of modeling is an important skill for scientists to develop.  Students discuss how this model is limited and how it could be improved over time.  As appropriate, have students discuss how the transfer of energy drives the motion of the can. | If needed, reiterate to students that one important skill of scientists and engineers is to construct models to serve as helpful tools for representing ideas and explanations.  As the Confused Can illustrated, models are especially important when scientists are limited in their ability to see the internal workings of a system.  Models are limited in that they only represent certain aspects of the system under study.  If appropriate, facilitate discussion on how the transfer of energy drives the motion and/or cycling of matter. |
| **Elaborate** | Students should think of another example where a model is used to represent an idea or an explanation. They should draw, label, and briefly explain how their model represents their ideas and/or explanations. |  |
| **Evaluate** | **Formative:**  Each student presents their ideas to their team. Student teams collaborate to develop a final design plan. Students draw and label their final design plan.  **Summative:**  Group presentation:  Each group evaluates their design for success. Did it meet the established criteria? Did their final design match their planned design? How would students improve their design? If time allows, provide students an opportunity to redesign according to their improvement plans. | **Formative:**  Facilitate ongoing questioning & discussion  Promote discussion of diagrams/models and explanations.  **Summative:**  Evaluate group presentations |

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| **Teacher Notes:**  Students work in groups of three or four people. While the materials take some time to collect and prepare, you can use them over and over again.  **Constructing the Confused Can:**   1. Drill a ½ inch hole in the center of both the metal bottom and the plastic lid that is large enough to poke a rubber can through 2. Cut the ¼ inch thick rubber band in half. 3. Tie/attach the weight(s) to the middle of the rubber band. 4. Insert one end of the rubber ban through the open end of the can and secure it on the outside with the large paperclip or piece of a skewer stick. 5. Stretch the opposite end of the rubber band through the inside of the can and out through the plastic lid. 6. Secure that end with a large paper clip or skewer stick. 7. Place the second lid (if you have it) on the other end of the can with metal bottom (so that the can is balanced and rolls straight – it will work okay with one lid). Use paper and/or tape to cover the two ends for that the inside mechanism is not visible.   Test the can to see how it works and tweak as needed until it functions properly. |
| **Materials needed:**  **Confused Can**  An empty 13 oz., coffee can or similar can or container  2 plastic lids and 2 large paper clips  A ¼ inch thick rubber band (3.5 inches long or so) cut in half  1-2 large hex nuts or similar weights (medium swivel fishing sinkers work well)  **Student Models**  For each group of students, you will need the following materials:  An empty plastic peanut butter jar or similar plastic jar where cap attaches inside (clear jars work the best because students can see how the inside works). Dollar store 2 quart storage jars work well too.  Drill ½ inch holes in the top and bottom of each jar  A ¼ inch thick rubber band (3.5 inches long or so) cut in half  2 small paper clips and/or a couple of 1 inch pieces of skewer sticks  1-2 large hex nuts or similar weights (medium swivel fishing sinkers work well)  The materials don’t have to be exactly the same for each group. To make it more open ended, you can give each group a variety of materials including several rubber bands and several different weights. |

Lesson adapted from More Brain-Powered Science: Teaching and Learning with Discrepant Events, Thomas

O’Brien, NSTA Press, 2011