Topic: Rubber Band Robot Build

Teachers: Laura Scarfogliero and Donna Gobin
Genre: Science | **Unit: Energy**
Grade Level: 8th grade | **Estimated Duration: 1-2 single period**

Essential Question **(Domain 1: Planning and Preparation-Component 1c: Designing Coherent Instruction)**
● **To what extent do variables affect motion and force?**
Background Knowledge
Background Summary: During this unit, students will learn the effects of different types of forces on the motion of objects, through the study of the Newton's laws of motion. Newton's laws state: (1) an object at rest will stay at rest until an unbalanced force acts upon it. Every object moves in a straight line unless acted upon by a force. (2) The acceleration of an object is directly proportional to the net force exerted and inversely proportional to the object's mass. F=ma (3) For every action, there is an equal and opposite reaction. Energy is neither created nor destroyed, it is only transformed. Elastic potential energy is stored in each rubber band when it gets twisted by the rotation of the car onto the white flap hooks. Upon release the potential energy stored in the rubber band releases and transforms into mechanical energy. The force on the axle in the form of torque allows the car to roll forward. Once the robot rolls forward it has kinetic energy as well. **Lesson Objective:** ● Students are looking at another way to give the robot energy, using various rubber band, which creates its own potential energy. ● Design and build a robot that can run by pulling back the wheels to tighten a rubber band and then release it. ● Identify the types of energy present in the system. ● The students will understand that Models can be used to represent systems and their interactions—such as inputs, processes, and outputs and energy, matter, and information flows within systems. ● Students should be able to explain how changes in motion, perspective, and reference of objects, depend on different variables such as mass, direction of motion, and frame of reference.
Standards **(Domain 1: Planning and Preparation- Component 1a:Demonstrating Knowledge of Content and Pedagogy)**

<u>NGSS Standards</u>

MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]

MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]

MS-PS3-5: Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]

<u>NYS Science Standards</u>

5.1c An object's motion is the result of the combined effect of all forces acting on the object. A moving object that is not subjected to a force will continue to move at a constant speed in a straight line. An object at rest will remain at rest.

5.1d Force is directly related to an object's mass and acceleration. The greater the force, the greater the change in motion.

5.1e For every action there is an equal and opposite reaction.

Vocabulary (Domain I: Planning and Preparation - Component 1e: Demonstrating Knowledge of Students.)	**Prep Work/Materials (Domain 1 Planning and Instruction- Component 1e: Designing Coherent Instruction, Domain 3 Instruction- Component 3c: Instruction Engaging Students in Learning)**	**Cross Curricular Connection (Domain I: Planning and Preparation - Component 1a: Demonstrating Knowledge of Content and Pedagogy, Component 1b: Demonstrating Knowledge of Students.)**
kinetic energy potential energy energy distance force acceleration gravity friction Newton's Laws transfer mechanical energy thermal energy torque	EV3 robot measuring tape rubber bands tape/sticker (to mark floor)	Math Technology Engineering

Differentiation **(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)**	
• Bodily kinesthetic learners - Hands on Rubber Band Robot Activity • Audio and Visual learners – Visual representation of activity in the Do Now. The observations collected throughout the activity. • ELL/Low reader - Guided notes printed for those who require them • Technology- Utilizing Lego Mindstorms robot kit and digital program • Enrichment: Change the length and/or thickness of rubber band and conduct the experiment again. • Extended time for those who require it • Small groups • Individual attention from ICT teachers and paraprofessionals • Resource room remediation for those who require	
Procedure **(Domain I Planning and Preparation-Component 1e: Designing Coherent Instruction, Domain 3: Instruction - Component 3b: Using Question and Discussion techniques Domain 3: Instruction - Component 3c: Engaging Students in Learning)**	**Student Engagement (Teacher Assessment)**
1) Introduce the problem of the day (how is energy transferred from the rubber band to the robot) Lead a classroom reviewing types of energy (kinetic,mechanical,thermal and potential), the transfer of energy and Newton's Laws. 2) Do Now: Create a KWL Chart about energy type and transfer with the class. *Reference: Rubber Band Activity Worksheet* 3) Demonstrate how to properly rotate wheel with rubber band attached to white flaps. 4) Assign group roles (Wheel Rotater, Data recorder, Distance measurer, Group Leader, Presenter) 6) Direct students to develop a hypothesis and reasoning. 7) In small groups, direct students to conduct experiment and record data utilizing Student Data Collection Directions. . 8) Circulate and motivate students to start their data collection. Asking students to describe what they are measuring, and documenting data on worksheet. 9) After performing this experiment 8 times (twice at 2,4,6,8 tire rotations), analyze data and predict the outcome of a rotation not given. Students will graph the 8 trials and use that additional resource to make connections to assist in the development of their predictions. 10) Students will use the model of this system to label types of energy in diagram on worksheet.	

11) Students will explain and discuss how energy was transferred in this model. 12) Extension: Students can conduct additional experiments alternating the rubber band length and thickness. **Student Data Collection Directions:** 1. Place the robot on the ground. 2. Attach each rubber band to its white flap. 3. Pull it back a specific distance indicated on data table 4. Prior to release, mark starting point of robot. 5. Release robot. 6. As the robot moves, mark endpoint.and measure how far it moved from starting point. 7. Repeat steps 1-6 for every value in data table.	
Assessment *(Formative or Summative)* (Domain 1 Planning and Instruction- Component 1e: Designing Coherent Instruction, Domain 3 Instruction- Component 3c: Engaging Students in Learning, Domain 3 Instruction- Component 3d: Using Assessment in Instruction)	**Student Engagement (Teacher Assessment)**
Pre-assessment: (Do Now) Assessment will occur during lesson and after the lesson, by gauging understanding and mastery through student responses to lesson discussion as well as their answers to the in class activity worksheets. We will wrap up by answering the objectives; reviewing in class worksheets, and having the students summarize the lesson activity. KEY Questions: Consider the transfer of energy in this situation. How are you inputting energy into the system? Why types of energy are involved this system? Is this better than the collision technique of energy transfer? Why or why not? What is important about this activity?	

Additional Resources