The Car with a Lot of Potential

Subject Area(s) Measurement, Physics

Associated Unit Energy of Motion

Associated Lesson None

Activity Title The Car with a Lot of Potential

Header Insert Header Figure here, centered

Image 1

ADA Description: Student observing the gear train motion of LEGO vehicle

Caption: Image 1: Student thinking about gears in motion

Image file name: student002.jpg

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Grade Level 4 - 5

Time Required 45 minutes

Group Size 3

Summary

Working in teams of three, students perform quantitative observational experiments on the motion of LEGO vehicles that are powered by the stored potential energy of a rubber band. The students will have the opportunity to experiment with different vehicle modifications (e.g. wheel type, payload, and lubrication) and monitor the effects on vehicle performance. The main point of the lesson, however, is to communicate to the students that through the manipulation of mechanics, a rubber band can be used in a rather non-traditional configuration to power a vehicle. In addition, this lesson reinforces the idea that elastic energy can be stored as potential energy.

Engineering Connection

Engineering applications typically require the manipulation and transference of energy. This activity provides students with an example of the application of the elastic energy of a rubber band to a purposely non-ideal mechanical setup, mimicking the real world's struggle for efficient engines and aerodynamic designs. The students will test the design and tabulate observations based on varied experimental parameters.

Engineering Category

Relates science concepts to engineering.

Keywords

Potential, energy, motion

Educational Standards[1]

- New York Science (1996): Physical Setting, Standard 4; Engineering Design, Standard 1

Learning Objectives

After this activity, students will be able to:

- Test the effects of altering the number of turns of a rubber band on the motion of the vehicle, reinforced with quantitative results
- Test the effectiveness of varying one or more of the following on vehicle motion: wheel type, payload weight, rubber band type, and lubrication
- Restate the importance of experimental consistency and how this is established between sequential trials using the on-board potential energy gauge
- Report on the conclusions and collaborate with other groups to optimize vehicle parameters

Materials List

Each group needs:

- 1 LEGO rubber band vehicle, pre-built for each group (see attachment for building instructions)
- Various rubber band configurations pre-connected to LEGO TECHNIC connectors

Introduction / Motivation

Image Insert Figure 1 here, centered

Figure 1
ADA Description: Example of a crudely constructed vehicle that transforms the (kinetic) energy in wind to usable energy for vehicular motion
Caption: Figure 1: Wind-driven vehicle from 1916
Image file name: Popular_Science_Monthly_-_Feb_1916_p170_-_Landboarding_history.jpg
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The scientist and engineer must consider the concept of energy as something invested that is further transformed. Many mechanical, chemical, electrical, and hybrid inventions thereof are founded upon this energy storage and conversion principle. Consumer solar panels, geothermal home energy solutions, and hybrid vehicles are just some of the pertinent real-world examples. However, the emphasis on energy may be obscured by the technological and physical complexities of such examples. This activity shows clearly the conversion of rubber's inherent elastic energy into mechanical motion with simple and relatable LEGO parts.

In order to further emphasize that this is no magic, but rather the benefit of mechanical engineering's ability to transform energy, the teacher may introduce (or conclude) the activity by displaying the disassembled rubber band vehicle as only consisting of simple unassuming LEGO pieces.

Procedure

Background

The conversion of energy is prevalent throughout our daily lives. The activity may begin by introducing common examples of the different types of energy, e.g. elastic, thermal energy, vibrational energy, electrical energy, etc. Vehicles are powered by many

different sources these days, from biodiesel to solar power. The interconversion of these types of energy may also be emphasized and discussed with the students. Finally, settle upon the idea of elastic energy and the common example of the rubber band as a source.

Before the Activity

- Construct enough LEGO rubber band cars for all groups
- Ensure that the wheels can wind up the rubber band and that the potential energy is properly and fully released. You may have to lightly coat the rubber band in talcum powder to ensure that it does not stick to itself upon winding.

With the Students

1. Instruct the students on the theory of the rubber band vehicle and its operation.
2. Allow the students to experiment with the operation of the vehicle on the floor or at their desks (Image 2)

Image Insert Image 2 here, centered

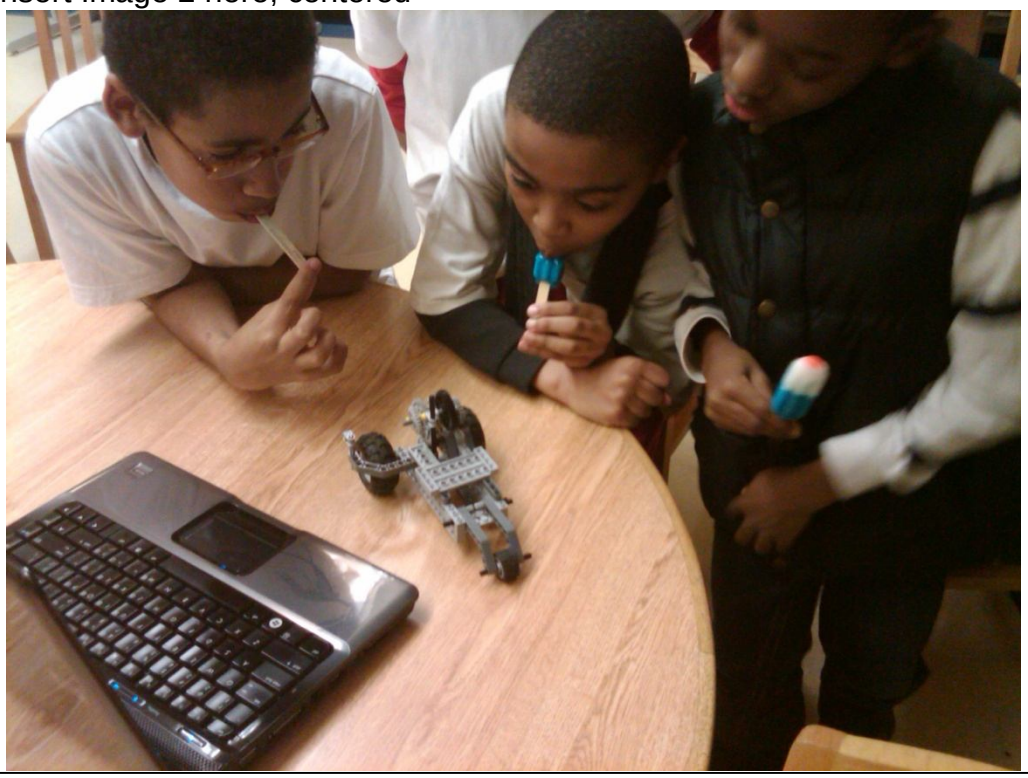

Image 2
ADA Description: Allow students to experiment with the operation of the vehicle on their own for some time
Caption: Image 2: Students studying the design of the vehicle prior to starting the experiments
Image file name: student001.jpg
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3. Design an experiment with the students to examine the effects of varying one of the following parameters. Compare the rubber band to a car's engine and the

various ways to optimize its performance. They may use a meter stick or tape measures to evaluate the distance that the vehicles travel.

a. Front wheel, type of (Figure 2)

Image Insert Figure 2 here, centered

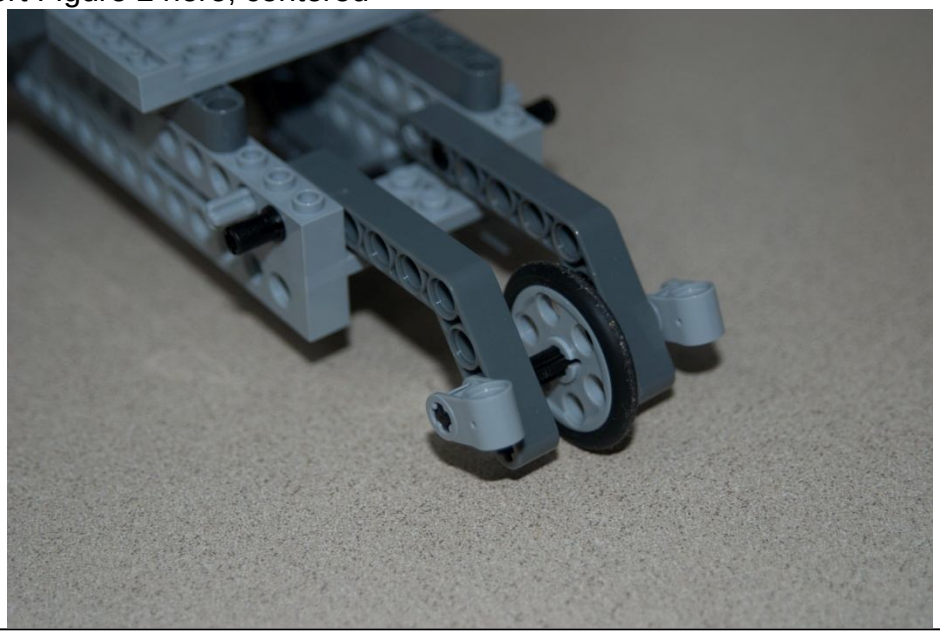

Figure 2
ADA Description: Alternative front-wheel configuration to that of the pre-designed vehicle
Caption: Figure 2: One alternative that students may be able to construct and observe the effect thereof
Image file name: front-wheel.jpg
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b. Lubrication (talcum powder) coating on the rubber band
c. Rubber band (engine), type of
d. Additional payload (Figure 3)

Image Insert Figure 3 here, centered

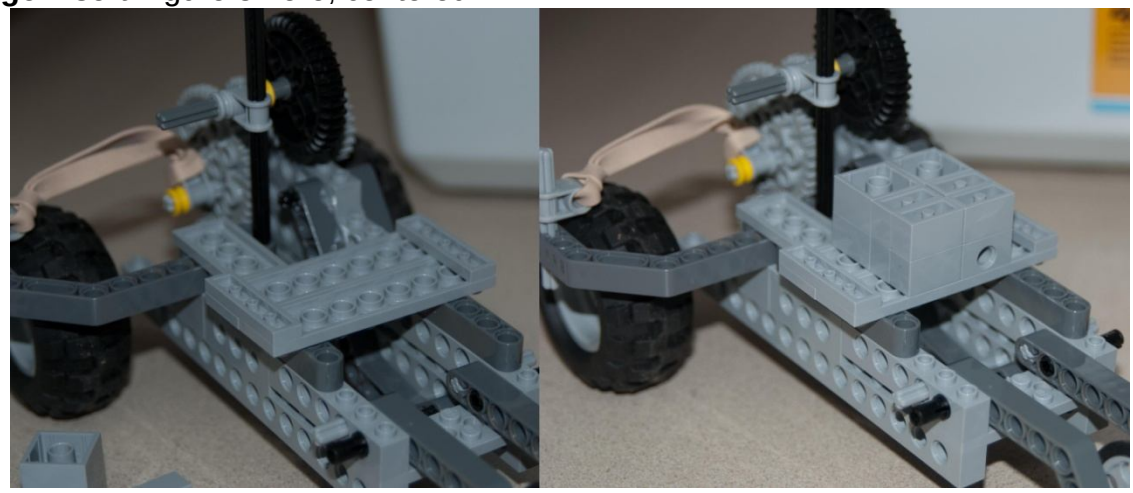

Figure 3
ADA Description: Adding payload to the vehicle should decrease the distance traveled given a constant energy input
Caption: Figure 3: How vehicle design accommodates for payload additions
Image file name: payload.jpg
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4. Emphasize to the students to consider the potential energy meter (Figure 4) that is built into the vehicle when designing experiments. Ideally, an experiment should be carried out under the same conditions (i.e. same potential energy). Students can use the meter to ensure that the rubber band is wound the approximately the same number of times every time they conduct a test.

Image Insert Figure 4 here, centered

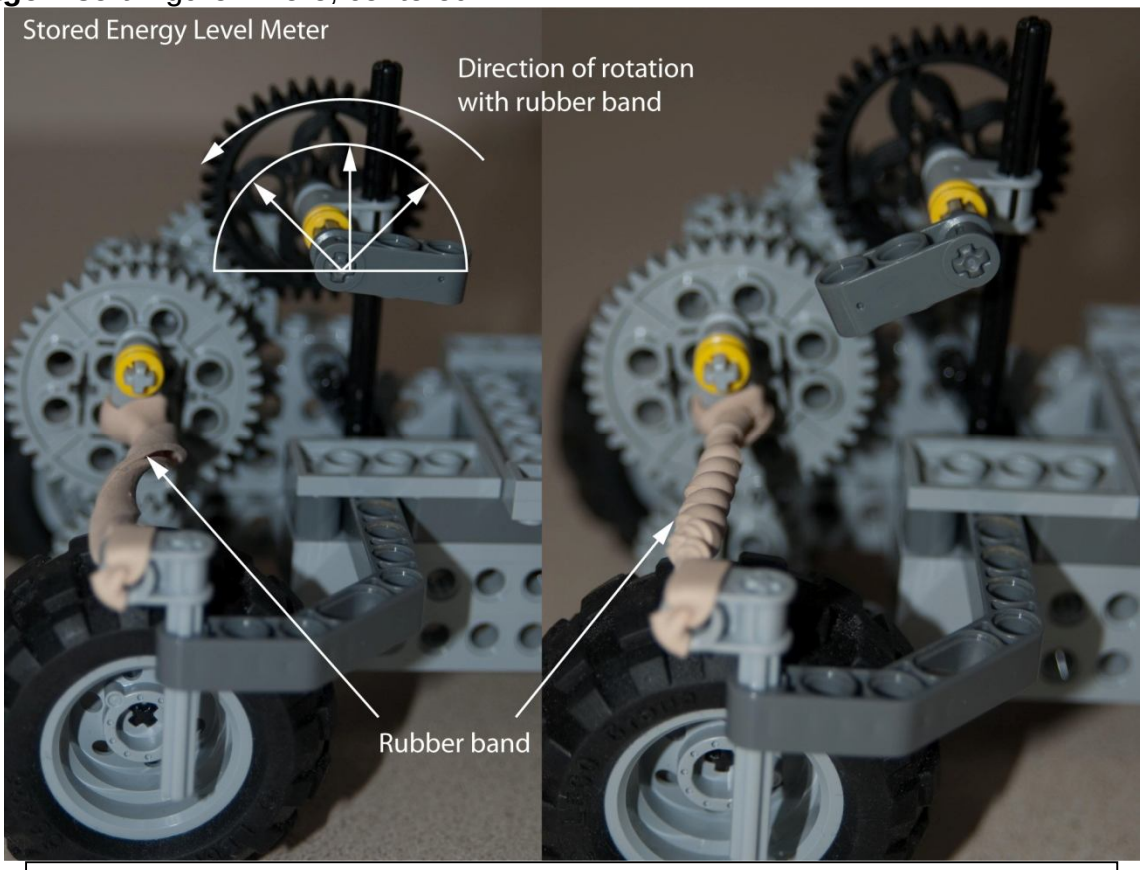

Figure 4
ADA Description: Instruct student on how to properly read and use the potential energy meter as they conduct their experiments
Caption: Figure 4: How to use the potential energy meter
Image file name: energy_meter.jpg
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5. Tabulate the results and incorporate the findings into an optimization experiment with all the groups of students and see if the distance traveled by the vehicle is enhanced. Alternatively, encourage the groups to work with other groups to collectively optimize the vehicles performance based on their collected data.

Attachments

Building instructions for rubber band vehicle and electromechanical ruler – building_instructions.pdf

Assessment

Activity Embedded Assessment

Prediction: Ask the students to consider modern cars with respect to variables such as wheel type, lubrication, tires, and engine. Ask the students how they think changing these variables may improve or hinder the performance of a vehicle.

Post-activity demonstration: Ask the students to consider modern cars and what happens when you push the engine too far. Then, in similar fashion, wind the rubber band car up until the point of failure. Ensure that the students witness the structural failures that ensue, reinforcing the point of energy storage limits of certain mechanical designs.

References

[1] NYLearns.org. University at Buffalo. Accessed January 27, 2009 (Provides NYS standards, educational resources and assessment) http://www.nylearns.org/

Redirect URL

http://GK12.poly.edu

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Contributors

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