



Rubber Band Powered Car

A Freshman Engineering Design Project
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Overview:

For this project, students will work in teams to design a rubber band powered “car,” using only the materials provided to them by the instructor and following given design constraints. Upon completion of the project, teams will enter the vehicles in a competition against the other student teams and turn in a team written report detailing the project and their design.

Learning Objectives or Student Outcomes:

By the end of this lesson or activity, students will be able to

1. design a rubber band powered “car,” given a specific set of unalterable design specifications that must be met;
2. design this vehicle for optimal performance in speed, distance and power;
3. enter this vehicle in a competition with other student-designed vehicles; and
4. complete an team written report detailing the project.

Length of Lesson:

This project is generally one of two or three in the semester. The length of the lesson will depend on a few factors: the amount of in-class time devoted to the project, the out-of-class time deemed necessary by the instructor, and what other activities will be taking place during the duration of the project.

Team Size/Composition:

Teams of 4 work best; if necessary, a few teams of 3 or 5 may be formed.

How is *positive interdependence* ensured?

Each team creates one vehicle, working together to develop the design using the one set of materials and to carry out their plan. In addition, the final written project report is a **team** report.

How is *individual accountability* ensured?

Peer evaluations may be used to ensure individual accountability.

Assessment:

Students will be informed of deliverables prior to beginning the project. These deliverables include:

- Team-designed rubber band powered vehicle
- Team written report detailing the project

If available, projects from past semesters may be provided for students to see. Designs should be reviewed periodically throughout the duration of the project—either on established dates or randomly.

Team Skills Needed for Success:

Students need to have the ability to cooperate, communicate, and collaborate with other group members regarding their ideas and concerns.

How Are These Skills Emphasized?

The idea of one final product and report for the entire team brings the group members together. The competition at the conclusion of the project also builds a sense of camaraderie among teammates.

Materials to Be Provided for Each Team:

1. Corrugated cardboard box (10"x6"x3")
2. ¼" diameter by 18" dowel rod
3. 12 paper clips (4 each of 3 different sizes)
4. 21 rubber bands (7 each of 3 different sizes)

Instructions to Students:

1	<p>Introduction and Purpose</p> <p>As an engineer you may often be confronted with the development of a design concept in which you are given a specific set of unalterable specifications (or criteria) that must be met (often referred to as design constraints). These constraints may take on the form of: 1) a limited budget; 2) having to use special materials because of a hostile environment; 3) geometry/shape and weight requirements; and the like. In order to investigate your ability to cope with a situation such as this, you have been provided a specific bill of materials, which is sufficient for you to construct a <i>rubber band powered car</i>. Your vehicle should be designed for optimal performance in the following areas: speed; distance; and power. To test the effectiveness of your final design, in the aforementioned categories, your vehicle will compete against all other vehicles in the class. The result of this competition will, in part, determine a portion of your grade on this project.</p>
2	<p>Design Constraints</p> <ol style="list-style-type: none">1. The materials (except fastening devices) provided to you are the only materials that may be used in the construction of your vehicle. For the purpose of this project, fastening devices are defined as "glue," "tape," and "staples."2. The vehicle must have a minimum of 3 wheels, all of which must support the total weight of the vehicle (both with and without cargo).3. The vehicle must have an "engine" powered by rubber bands, which will be enclosed within the body of the vehicle.4. The vehicle must start from a resting position and cannot otherwise be catapulted or slung into motion. Once released, the vehicle must operate without intervention.5. The vehicle must have a cargo area capable of carrying an additional 500g mass that is roughly in the shape of a coke can (either standing upright or on its side).

	<p>6. Geometric constrains (not including the wheels) are:</p> <ol style="list-style-type: none"> Minimum top view area is 75 in². Minimum projected back view surface area is 30 in². Minimum projected side view surface area is 22.5 in². Minimum projected front view surface area is 7.5 in². Overall vehicle length 12 in. Overall vehicle width 5 in.
3	<p>Performance Measurements</p> <p>Vehicle speed will be measured by a distance/time relationship where the distance is some predetermined perpendicular length from the start line. Maximum distance will be measured radially from the start line to the final resting point of the vehicle. Vehicle power will be estimated by attaching a sled (which has a known, but unspecified mass) to a hook on the back of the vehicle and measuring the distance the sled is displaced by the vehicle and the associated time. Where applicable, time will always be measured when the vehicle comes to a complete stop.</p>
4	<p>Report Instructions</p> <p>This assignment is a final project report on your car development, testing, and conclusions. Please note that the audience for the report includes all of your instructors, including your English instructors. Therefore, your report should include all requested information and be written on a level that an educated but non-technical audience can understand. This may mean including an occasional definition or choosing to use a general rather than technical term where feasible. The report requirements come partially from engineering and partially from English. Please carefully check to make sure that your report fulfills all requirements.</p>
5	<p>Project Deliverables</p> <p>Just to reiterate—each team must submit the following:</p> <ul style="list-style-type: none"> One team-designed rubber band powered vehicle A team written report detailing the project

Report Requirements

Engineering Content Requests

From an engineering design standpoint, the report of the project should address the following areas:

- problem identification (an introduction to the problem),
- preliminary ideas or concepts (copies of rough sketches should be included)
- refinement of a design (scaled sketches of the final design are requested in the project statement), and
- analysis and implementation (results of the demonstration of prototypes).

Experimentally obtain distance versus time data (as described below) and provide a plot of this information.

- From the experimental data, estimate and plot the vehicle's velocity versus time.
- From the experimental data, estimate and plot the vehicle's acceleration versus time.
- Using the above graphs, determine an appropriate velocity function and analytically estimate the distance the vehicle traveled and compare this to the measured data.
- "Estimate" the amount of energy stored in your engine just prior to the release of the vehicle. Compare this to your estimate of how much energy was actually delivered to the vehicle.

Include a final description of your design that includes

- a single prototype
- the results of the project
- the functionality of the design

At this point, the engineering professors are not interested in detailed design drawings, just good sketches of the final design and a report that documents the complete design process. Analysis is limited to what is asked for in the project statement.

English Requirements

In contrast to the technical information contained within the report, we will look at the quality of your organization, development and writing. From an English standpoint, the report should adhere to the following qualifications:

Overall

- is well-organized into logical, separate report sections.
- uses a clear system of highlighted headings to identify report sections.
- demonstrates an understanding of the Killingsworth, Chapter 9 reading (provided in class)

Content

- begins with a clear introductory section
- thoroughly reviews the methods by which the product (the car) was developed.
- documents the results of the test trials.
- discusses (analyzes) the product's (car's) performance, indicating strengths and weaknesses and comparing expected results to actual results.
- includes any conclusions or implications drawn from the work.

Writing Style

- uses clear sentences with active wording, only using the objective style when appropriate.
- uses well-structured paragraphs.
- is consistent in style (doesn't sound like it was written by four different authors).
- uses general audience terms where possible and appropriate (no unnecessarily complex writing).
- avoids errors in grammar, spelling and punctuation.

Graphics

- are titled and labeled.
- are referenced in the text and explained as needed.

A clear understanding of this project-report process will benefit you in the future. This presentation is similar to future projects but contains less detail. Such work is commonplace in the professional world.