Lesson Plan for Rubber Band Powered Cars

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Introduction/Background Info

In some way or another, engineers are involved in the production of almost everything around you. They can design buildings and planes, develop parts of our iPods and cell phones, and manufacture medicines. Engineering is a very broad discipline and is split up into many smaller and more specialized fields. The School of Engineering at UCLA offers over ten different areas of study, including mechanical, aerospace, electrical, chemical, civil, and bioengineering. Engineers, on the most basic level, are problem-solvers. They work together with many other engineers and scientists from different backgrounds within constraints to find creative solutions to problems in the world. To do this, they often use the **engineering design process**. In this lesson, we will focus on the following series of steps:

1. Identify objectives: What is the product supposed to do? Who is it for?
2. Identify constraints: What are the limitations? (This project is mostly limited by the amount of materials and time, but engineers are often mindful of the price of materials and safety requirements.)
3. Brainstorm ideas: Each member of the group should add input to the design of an object. There is no "right" way to build something. Different ideas are often combined and expanded upon.
4. Choose a design: Decide on a unified design as a team.
5. Build a prototype: Work together to build the prototype (an early model for testing).
6. TEST! Pay attention to the weaknesses and strengths of the design.
7. Adapt the design: Change the prototype to better fulfill the objectives.
8. Repeat: Continue to test and refine the prototype. Try adding new objectives or constraints.

This project also introduces the students to energy. Energy can be divided into two general categories: potential and kinetic. **Kinetic energy** is the energy of motion. Two main types of kinetic energy are rotational and translational (for rigid, non-rotating objects). **Potential energy** is stored energy. It can be in many different forms including gravitational (falling objects), elastic (springs, bows), and chemical (fuel burned to convert to heat).

For this lesson, we do not need to give a comprehensive explanation of these concepts. Potential energy can be explained as stored energy that transforms into kinetic energy as an object moves. In this lesson, the car has potential energy when the rubber band is wound up and kinetic energy as the rubber band unwinds and the car moves forward.

Student Objectives

- Learn and be comfortable with the engineering design process with emphasis on teamwork and testing.
- Learn the difference between potential (stored) and kinetic energy and be able to identify when the car uses each type of energy.

Overview of Lesson Process

Part 1: Introduction as a class (10 minutes)

- Discuss energy. When do we experience it and are there different types of energy?
- Introduce kinetic and potential energy and provide examples (falling objects, a bow and arrow).
- Explain the engineering design process outlined in the introduction to this lesson plan.
- As a class, identify the constraints of the project (terrain, supplies, time) and the objectives (distance, size, speed, etc.).

Part 2: Building the cars in groups (30-40 minutes)

- Have students work together to come up with a design for their car.
- Students build prototypes with the given materials.
- Test the car on different surfaces, and change and improve the design, if needed.
- Race the cars against each other and see which ones go faster.

Part 3: Closing discussion as a class (5-10 minutes)

- Discuss what students found to be the strengths and weaknesses of their designs and why they think some cars went faster than others.
- How did testing their designs or working in teams help them better understand the objectives?
- Ask if the students were able to identify when kinetic or potential energy was being used.

Materials

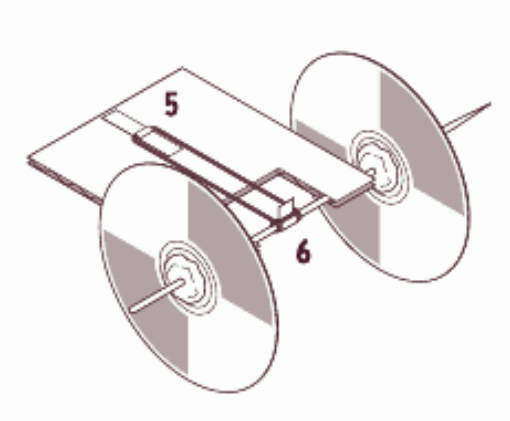
Item	Price	Retailer
CDs	$20 (50-pack)	OfficeMax (Item # 02238796)
Paper Plates	~$5	Smart & Final
Wooden Skewers	~$3	Smart & Final
Tape	$10 (2 rolls of masking tape)	OfficeMax (Item # 20580514)
Straws	~$5 (30-pack)	Smart & Final
Rubber Bands	~$3	OfficeMax (Item # 20792073)
Cardboard		
Scissors		

Procedures

Building the car:

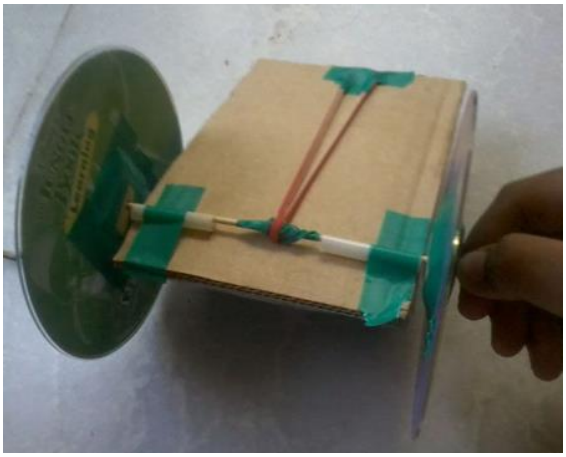
- In smaller groups, have the students come up with a general idea of how to build their car. Encourage them to work as a team to combine their ideas into a unified design.
- Have students build their prototype:
    - Use a piece of cardboard to make the body of the car. Depending on how the students decide to attach the rubber band to the axle, they may need to cut a notch in the cardboard.
    - Students can choose whether to use CDs or paper plates for the wheels. If using CDs, they'll need to tape another piece of cardboard over the center hole to stick the skewer (axle) through.

- Use the wooden skewers as axles. One way to attach the axles to the car is to stick the skewer through the cardboard and attach it to the wheels. The students may also cut up the straws and tape them on top of the cardboard body so that the skewers can slide through them and into the wheels.
- Attach one end of the rubber band to the skewer and the other end to the front of the cardboard body.
- To power the car, wind the rubber band around the axle by turning the skewer. Let go, and the car should move forward!



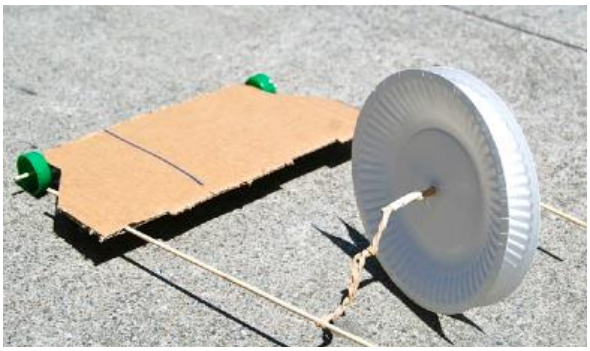
In this design, the skewer is put through the cardboard instead of on top. They used a piece of tape on the skewer to act as a "catch" for the rubber band and also cut a notch in the cardboard body so the skewer could spin freely.

(From PBS Kids)



In this design, straws were cut up and taped on top of the cardboard body. The skewer can then slide through the straws instead of through the cardboard. Also, pieces of cardboard are taped over the holes of the CD for the skewers to poke through.

(instructables.com)



This is another design that uses two paper plates taped back to back instead of CDs for the wheels.

(From the CSW Network)

- Remind students to test their designs multiple times and refer to their original objectives.

Closing Discussion

- How many times did you test your prototype? What kind of problems did you run into and how did you fix them?
- How did testing and working in teams help?
- If you tested your car on different surfaces, where did the car go faster?
- Compare the cars (weight, wheel size, overall design). Which ones went faster and why do you think they went faster?
- If there is time, try adding more constraints, like additional weight, to your cars. Does it still work? How would you change your design to make it better?

Resources

For information on kinetic energy: http://en.wikipedia.org/wiki/Kinetic_energy

For information on potential energy: http://en.wikipedia.org/wiki/Potential_energy

For information on the engineering design process: http://www.teachengineering.org/engrdesignprocess.php

Various examples of rubber band powered cars:
http://pbskids.org/designsquad/parentseducators/resources/rubber_band_car.html
http://www.instructables.com/id/How-to-make-a-simple-pull-back-carrubber-band-pow/
http://cswnetwork.org/community/projects/pdf/140.pdf