Title: Balloon Cars
Subject Area: Physical Science - Newton's Laws
Author: L. Logan
Level: 7-8
Activity Time: 2-3 Class periods of 45-50 minutes

Device:
TI-73 Explorer™

Apps:
DataMate

Software:
TI Connect™, TI-GRAPH LINK™
Accessories:
CBL™/CBL 2™, CBR™/CBR 2™, Sensor - Motion Detector, TI Connectivity Cable, TI-GRAPH LINK™ Cable, Unit-to-Unit link cables

Activity Overview

In this activity students will investigate the forces and motion related to a small, easy to build balloon-powered car. Students will design and build a balloon-powered car to specifications based upon a desired goal: 1) speed and/or 2) distance. Students' will use a motion detector to measure the speed and acceleration of the balloon-powered car. They will also investigate the effects of the size of the propulsion tube on the speed and distance of the car.

Before the Activity

- Connect the TI-73 to the CBL™ unit
- Connect the motion sensor in the DIG/SONIC on the CBL 2
- Download DataMate™ program

Objectives

Upon successful completion of this activity, students will be able to:

- Explain the recursive design-build-test-redesign model employed by engineers
- Infer the relationship between force, mass, and acceleration
- Accurately measure speed and distance using metric units
- Analyze and evaluate performance of toy cars built to design specifications

Activity

Part 1 – Car Assembly (40-45 minutes; groups of 2-3)

1. Discuss the role of engineering in making our society a better place in which to live. Cite the value of various inventions as means to making our daily lifestyle what it is e.g. advances in medicine, communication, transportation, etc. Stress how these technologies have improved our health and

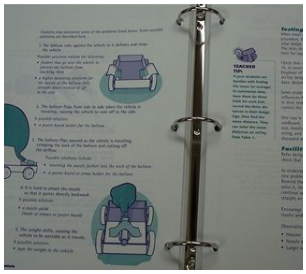
welfare, throughout the years. Discuss the career opportunities of engineering; explain how engineers solve problems as they design, build, test, and re-design prototypes for companies.

2. Propose the challenge of designing and building a balloon-powered car to achieve one of two goals:

- highest average speed
- farthest distance

Note: You may wish to allow students to choose their desired goal; or, you may assign half of the groups to design and build for speed, and have the other half design and build for distance.

3) Provide materials for the assembly of a balloon-powered car. A complete kit containing all the needed materials is available through a partnership agreement with the Society of Automotive Engineers (see www.awim.org).



If you do not wish to purchase the kits, the balloon-powered cars can be made using basic materials such as tag-board for the bed, straws for the axle holders, plastic tubing for the balloon assembly (3 sizes: ½ inch, 3/16, 5/16), and push-up pops for the wheels and axles. The bed of the car should be roughly 2cm deep x 6.5cm wide x 15cm long. The axle holders can simply be taped to the bottom of the bed. At one end of the bed, students must account for the balloon assembly. One option is to bore a hole in the rear of the bed for the plastic tubing to fit through. Another option is to build a platform that sits atop the bed, thereby raising the height of the tubing (see above).   Ideally, students would design the car to allow them to change the size of tubing without building a new bed e.g. perhaps design various pieces of tag-board to match the tubes sizes and affix these to the car bed.

4) Testing – prior to mounting the balloon assembly (a balloon rubber-banded to the plastic tubing), it is wise to test the car chassis for accuracy in rolling in a relatively straight line. This can be done using a simple ramp e.g. roll the car down the ramp and observe its direction movement. Adjustments to the car may be needed e.g. wheel alignment, balance, etc. Following the testing and subsequent adjustments, students may mount the balloon assembly; they are now ready for final testing.

Part II – Data Collection & Analysis
1. Review the data needed to measure average speed (time and distance) and distance (simple metric unit of length) 2. Discuss the design goals (speed or distance) and agree upon a way in which to measure each. Incorporate the TI 73 and motion detector into the data collection process. Agree upon the rules for data collection e.g. number of trials, order of trials, etc.

2. Arrange a location for the balloon-powered car data collection. Collect data as agreed upon by the rules set forth by the class. Be sure that students have built data collection charts. Note: As part of the rules and depending upon time constraints, you may wish to allow students to make adjustments to

their cars between trials.

3. Enter data into TI 73 lists e.g. L1, small tube, L2 medium tube, etc. Calculate the mean of each list. Use 2^{nd} y (plot menu) to make a box plot for L1 in Plot 1, L2 in Plot 2, etc.

4. Interpret the box plots and discuss optimum performances and less stellar performances. What relationships are noted between tube size and performance on stated goals?

5. Provide an opportunity for student to re-design cars using a preferred tube size based upon what was learned through the analysis e.g. students may infer that for optimum distance, the smallest tube is desirable. Re-test cars and collect data for analysis, as before. Compare and contrast the graphs and draw conclusions as appropriate.

Extension – Determine a way to measure acceleration and graph the results for the stated performance goals.

Assessment
To what extent were students able to:

- Explain the recursive design-build-test-redesign model employed by engineers
- Infer the relationship between force, mass, and acceleration
- Accurately measure speed and distance using metric units
- Analyze and evaluate performance of toy cars built to design specifications

Assessment Questions – Balloon Powered Cars

1. What is an engineer and what does he/she do?

2. If you were asked to create an invention, how would you begin?

3. T or F Many products that we purchase and use in our daily lives are tested prior to distribution in stores.

4. What is a force? Describe an example of force that you experienced today.

5. What data sets are needed to calculate speed?

6. What is the metric unit of length?

7. In what ways are mass and acceleration related?

8. What aspects of your balloon-powered car were successful? Provide an example of an adjustment to the car that improved your performance.

9. What size of tube would you use if you wanted to achieve both speed and distance? Explain your reasoning.

10. Based upon what you learned, what would you do differently if you were able to start all over? Why?

11. Describe what you learned as a result of this activity.

12. How could you communicate what you learned, to others?