Science Experiment:
Balloon Car Challenge
Project: Engineering, Robotics, Fluid Power

Introduction

Balloon-powered cars, like the ones in Figure 1, are fun to build and even more fun to play with. In this project you will be challenged to build and test your own balloon-powered car. A balloon-powered car consists of three main parts:

- The body of the car
- The wheels of the car
- The axles, which connect the wheels to the body, and allow the wheels to spin

Have you ever blown up a balloon and then let it go, without tying it shut? The air rapidly escapes from the balloon, making it zip all over the room! This is because when you blow up a balloon, you increase the air pressure inside the balloon. This air pressure stretches out the rubber balloon material, just like stretching a rubber band. Both the air pressure and the stretched rubber store potential energy, or energy that is "waiting" to do something.

When you let the balloon go, the rubber contracts, and air is rapidly squeezed out the opening of the balloon. The potential energy inside the balloon is converted to kinetic energy, or energy of motion, of the fast-moving air through the opening. Because the air is pushed out rapidly backwards, there is a reaction force that pushes the balloon forward. This principle comes from Newton's third law of motion, which states "for every action, there is an equal and opposite reaction."

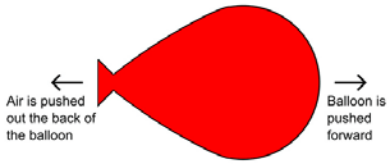

Figure 3. According to Newton's third law of motion, when air is pushed backwards out of the balloon (out the end with the opening), there must be an equal and opposite reaction force that pushes the balloon forward (the end opposite the opening).

When you just let a balloon go on its own, it tends to randomly fly around the room, and is almost impossible to steer. However, when you attach the balloon to a car, like the ones shown in Figure 1, you can harness the balloon's energy to propel the car forward! The engineering goal in this project will be to design, build, and test a car that is powered by nothing but a balloon. You want to design your car so it can travel as far as possible.

Terms and Concepts

- Body (of a car)
- Wheel
- Axle
- Air pressure
- Potential energy
- Kinetic energy
- Reaction force
- Newton's third law of motion
- Design requirements
- Iteration

Supplies:

- CDs (4)
- Latex balloons, 9 inch (2)
- Jumbo straws, approximately 1/2 inch diameter and 9 inches long (2).
    - Note that these are also referred to as "milkshake straws" or "smoothie straws." They are available from Amazon.com.
- Wooden pencil, 7 3/8 inch long (2)
- Sheets of paper, 8.5 x 11 inch (10)
- Jumbo paper clips, 1 3/4 inch long (6)
- Scotch® tape (1 roll)
- Scissors (allowed as a tool only, not a construction material)

Time: 2-5 hours

What to Do:
The goal of this project is to design and build a balloon-powered car. *Balloon-powered* means the car is propelled forward by nothing other than air escaping from a balloon. Since this is an engineering project, here are the **design requirements**.

- The car should be sturdy and not fall apart when in use.
- The car should go straight.
- The car should go as far as possible.

Designing Your Car
Once you have created your design requirements, you need to start designing your car. The design phase is an important part of the engineering design process. There is no fixed procedure for this section; you get to come up with your own design! If you are new to the engineering design process, here are some suggested steps to get you started:

1. Do some background research on balloon-powered cars. Do an internet image or video search for "balloon powered car" and you will see many different designs, made from different materials. This can inspire your design.
2. Think about what materials you want to use for your car, and how you will connect the different pieces together. For example, what do you want to use for wheels?
3. Make a sketch of your design on paper before you start building. Figure 4 shows an example sketch of a design. Documenting your design ideas is important for an engineering project, especially if you are entering a science fair.

Building Your Car
Once you are done designing your car, it is time to start building! Again, there is no fixed procedure for this section. How you build your car will depend on the design you came up with and the materials you decided to use. Once you think your car is ready, move on to the next section to begin testing.
Optional: If you have a digital camera or smartphone, take pictures of your car. This will help you document your design process.

Testing Your Car
Engineering projects rarely work perfectly on the first try! Now it is time to test your car, and possibly redesign it or make improvements, depending on how well it works. This is called **iteration**, which is an important part of the engineering design process. Here is a suggested procedure for testing your car:

1. Inflate the balloon (by blowing through the straw, if you attached it to a straw).
2. Pinch the end of the balloon shut, or put your finger over the end of the straw, to prevent air from escaping.
3. Put your car down on the floor, and let go of the balloon.

    a. Optional: If you have a digital camera or smartphone, you can take a video of your car's test run. It might help to have a volunteer operate the camera while you operate the car.
4. Watch your car closely! Does it move forward? Pay close attention to whether the car meets your design requirements, and write down your observations. For example:
    a. Does the car go straight?
    b. How far does the car go? Use a tape measure to record how far the car traveled from where it started to where it came to a complete stop, and write this distance down in your lab notebook.
    c. Did any parts of the car fall apart?
5. Repeat steps 1–4 a few times until you are comfortable handling your car and seeing how it works.
6. Depending on how well your car works, your next steps may vary. Write down your observations and ideas.
    a. If your car does not work at all (it does not move forward even a little bit, or it falls apart), try to figure out what is wrong. Are the wheels stuck? Is the car too heavy for the balloon to push? Do you need to use more tape to hold things together?
    b. If your car works, but not very well (it only moves forward a little, or it moves but turns to one side instead of going straight), try to figure out how you could improve it. Are the wheels or axles crooked, causing the car to turn? Are the wheels getting slightly stuck, preventing the car from going fast?
    c. Even if your car works well, think about what changes you could make to improve it. Can you modify your car to make it go even farther? What happens if you try to inflate the balloon even more?
7. Based on what you find in step 6, make changes to the design and construction of your car.
    a. Optional: If you have a digital camera or smartphone, take pictures of all the changes you make to your car. This will help you document the different iterations of your design process.
8. Repeat steps 1–7 until your car meets all of your design requirements. It might take you many tries to get your car working properly, and this is okay! There is no "right answer" to an engineering problem. Now, think about the design process you went through:
    a. How many different iterations did it take you to reach your final solution?
    b. Did you have to make major changes or do a total redesign of your car, or did you only make small changes and fixes?
    c. If you took pictures, compare the first picture of your car to the last picture. How much did your car change?
9. Repeat several test runs with your completed car, and record how far it travels. What is the longest distance you can get your car to go?

Contest:

We will have a contest at the end to see who went the farthest with the heaviest car. We will use the formula of Weight X distance to pick our winner. If you go outside of the competition area we will take off the amount of distance that any of your car is out of bounds (by centimeters).

Reflect:

- What is potential energy?
- What are some different ways potential energy can be stored?
- What is kinetic energy?
- What is Newton's third law of motion?
- What are some common materials and designs used to build balloon cars?

Apply:

- What are some other ways that we see energy in motion in our everyday lives?
- Why is understanding energy important?
- What ways can we continue to make things safer by understanding energy and movement?