**Build a Rocket Racer!**

*When I wanted a new skateboard my dad said, "Build one." So I did! We raced through the neighborhood streets to see who had the fastest board.*

When Leland wanted to buy a new skateboard, his father challenged him to build one. He soon learned how different aspects of design – the length and shape of the board or the size of the wheels – could change how fast the skateboard would go. Follow the directions below to construct your own rocket-propelled vehicle. You can experiment with ways to increase the distance your racer travels or its speed by modifying your design – just like Leland experimented with ways to make his skateboard go faster!

If you build your racer with friends you can hold drag races for speed or compete for distance. In this activity you will investigate basic forces that impact motion - *position, velocity, and acceleration*. All of these are related to Isaac Newton's Laws of Motion that govern our world and provide the foundation for rocket science.

The three Laws of Motion deal with position, velocity and acceleration:

- **Position** is an explanation of where something is, based on a certain origin (or starting place).
- **Velocity** is the speed and direction something is moving.
- **Acceleration** is how velocity changes with time.

You can find out more about Newton's three laws of motion in the *Adventures in Rocket Science* activity guide referenced at the end of this experiment or by searching educational resources available at NASA.gov.

**Materials and Tools**

- Four pins
- Styrofoam meat tray or other flat Styrofoam tray
- Styrofoam cups
- Masking tape
- Flexible straws
- Scissors
- Drawing compass*
- Marker pen
- Small round party balloon
- Ruler
- 2.81 ft (10 m) tape measure or other measuring markers for track
- Graph paper

Notes as you begin:

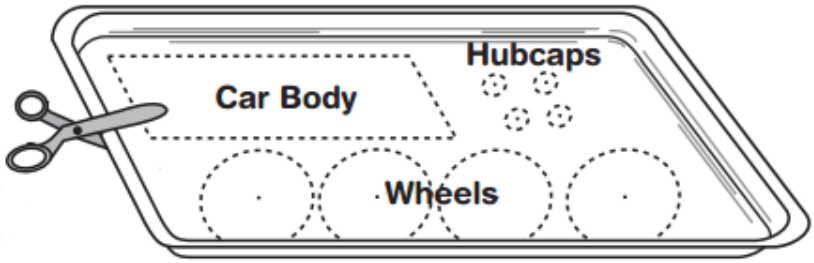
- Safety first! Always wear proper fitting goggles for experiments.
- If you don't have a compass you can trace circular objects to make the wheels or use the wheel and hubcap patterns provided
- Styrofoam cup bottoms can also be used as wheels. Putting hubcaps on both sides of the wheels may improve performance.
- Be sure to conduct your experiment on a stable, smooth surface such as a tile floor or carpeted floors with a short nap.
- Once you create and race your first vehicle, think about how to modify or improve your design and try it again!
- Be sure to measure how far your racer travels with each launch and track your data!

**Procedure:**

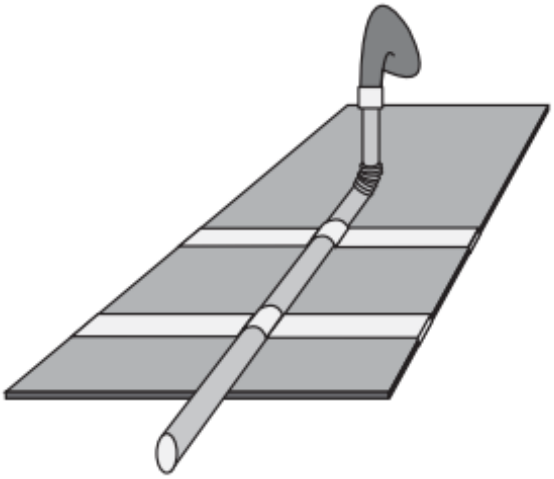
For this experiment the first step is to build your rocket racer. Once you construct and test your initial vehicle you can modify the design to improve distance or speed and compare results.

1. Lay out the patterns for your vehicle parts on a Styrofoam tray. You need 1 car body, 4 wheels and 4 hubcaps. Use a compass to draw the wheels or trace the circles from other items such as a tin can or paper cup. (You

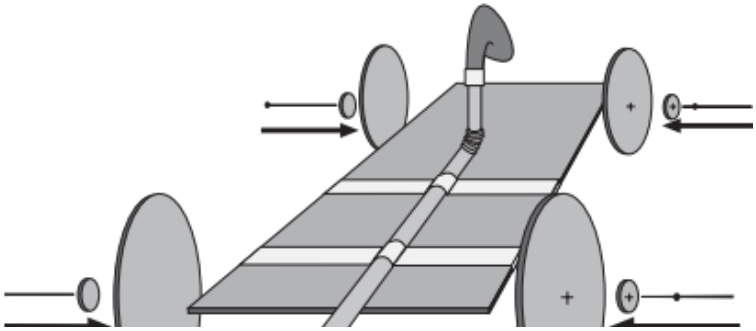
can also trace the wheel and hubcap patterns provided.) Cut out the vehicle parts.



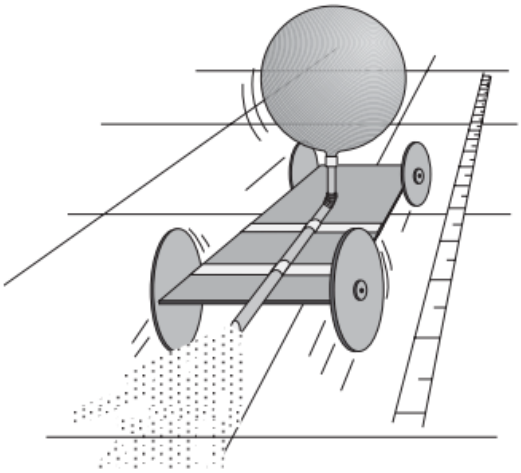

2. Blow up the balloon and then let the air out. Tape the balloon to the short end of a flexible straw and then tape the straw to the vehicle body (the long rectangle). This is the top of your vehicle. Make sure you leave enough of the straw hanging over the end of the vehicle body so you can blow up the balloon and then pinch the straw between your fingers.



3. Add wheels and hubcaps to your vehicle body by using the pins. Push the pins through the hubcaps into the wheels and then into the edges of the Styrofoam rectangle.



**4.** Blow up the balloon through the straw. Squeeze the end of the straw to hold the air until you are ready to race. Place the racer on floor and let it go!



**Questions to Investigate:**

In this experiment you were introduced to the Laws of Motion by launching your air propelled vehicle across a smooth surface. The force of the expelled air changes the *position* of your vehicle by propelling it across the floor. You observed its *velocity* as it moved and noticed a change in *acceleration* due to a decrease of air in the balloon over time. These are the basic concepts that provide the foundation for rocket science.

The study of motion is fundamental to understanding the dynamic properties of an object and how they are affected by factors such as altitude and weight, air temperature or density. From experiments like this one you can also see how concepts such as measurement and rate of change are important in designing vehicles and rockets.

**Design your own:**

Now that you have built your first racer and recorded your results consider other variables that might affect the outcome. What other factors might impact the speed or distance your vehicle can travel? Put another way - What forces could be slowing down your rocket racer?

Formulate new questions as you think about modifying your design to test for variables. Some suggested questions may be:

- What resistance did your racer encounter? (air resistance, obstacles on the racing surface?)
- Would a different type of material, such as cardboard, improve performance?
- How can I modify the design to improve the racer's speed?
- How can I modify the design to improve the racer's distance? (
- What happens if I use a bigger balloon, larger wheels or a bigger straw?

As you change the design of your racer to investigate the effect of an individual variable, keep track of your changes and results so you can compare and analyze them. Use the graph paper to draw out the dimensions and shapes before you trace and cut your pattern. Think about how your racer will look from the side, the front and the top view.

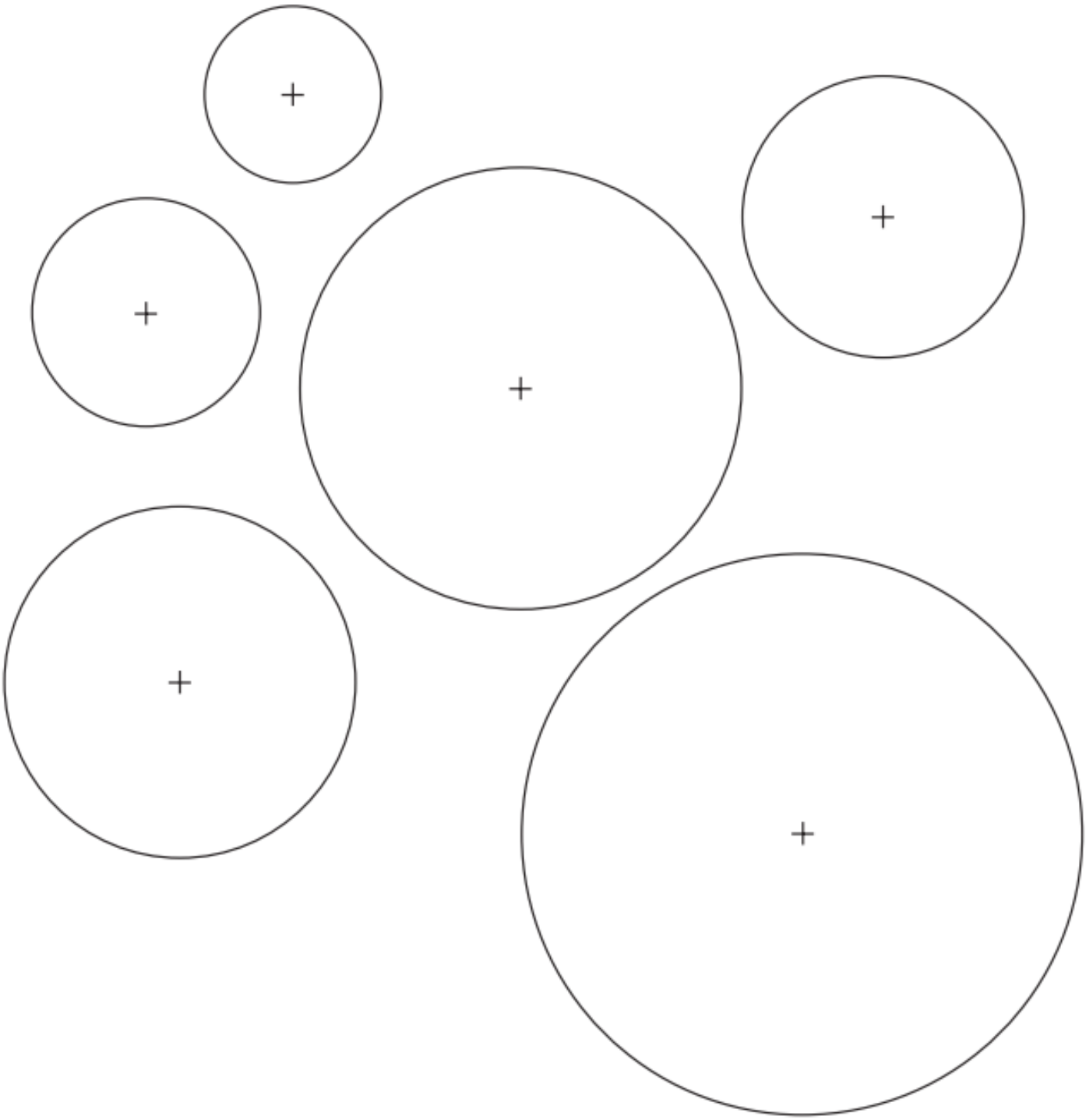
**Ideas for extra fun!**

Hold Rocket Racer races! Have a group of friends design and build individual racers and compete. To make sure each racer starts with the same amount of air:

- Make sure everyone uses the same size balloon
- Tie a loop of string around an inflated balloon attached to one of the racers.
- Create a loop of string of the same size for each racer, or use one loop and launch the racers individually.
- Inflate each balloon inside the string loop each time you test the racers. This will help ensure the balloon inflates the same amount each time.

For more advanced experiments, information on Newton's Laws of Motion or to learn how you can participate in NASA's rocket design challenge check out the activities in http://www.nasa.gov/pdf/265386main_Adventures_In_Rocket_Science.pdf

Wheel Patterns



Hubcap Patterns