STEM IN THE LAB

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# HOW DOES A HOVERCRAFT HOVER? *STAR WARS* EDITION

*Land speeders and hovercrafts appear in many places in Star Wars. In this activity, kids make a simple hover-inspired vehicle using a balloon and CD.*

*Have you ever ridden on a hovercraft? It is like gliding on a cushion of air! In fact, this is exactly what is going on. A hovercraft is a vehicle that glides over a smooth surface by hovering upon an air cushion. Since a hovercraft can travel on top of flat land or water, it is an amphibious vehicle. In this activity, you will get to build your own mini hovercraft using a CD or DVD, a pop-top lid from a plastic bottle, some glue, and a balloon. How will different amounts of air in the balloon affect how long the hovercraft hovers?*

# GRADE LEVELS: K-8

# VOCABULARY

***Hovercraft-*** *a vehicle or craft that travels over land or water on a cushion of air provided by a downward blast. A design was first patented by Christopher Cockerell (1910–99) in 1955.*

***Friction-*** *the resistance that one surface or object encounters when moving over another.*

***Aerodynamics-*** *the study of the properties of moving air and the interaction between the air and solid bodies moving through it.*

***Air Cushion-*** *the layer of air supporting a hovercraft or similar vehicle.*

# MATERIALS

- *Pop-top lid from a plastic drinking bottle. Reusable plastic drinking bottles sometimes use these kinds of lids.*
- *An old CD or DVD that you are willing to part with (it will not be playable after this activity)*
- *A medium-sized balloon (large enough to inflate to at least 11 inches around)*
- *Craft glue or super glue*
- *Stopwatch or timer*
- *Large flat surface for testing the hovercraft*

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# PROCEDURE

1. *Remove a pop-top lid from a plastic drinking bottle.*
2. *Glue the base of the pop-top lid to the CD (or DVD) so that the lid covers the hole in the center of the CD. If you use super glue, have an adult help, use caution, and follow all the instructions and safety warnings on the packaging. Allow the glue to dry completely.*
3. *Make sure the pop-top lid is closed.*
4. *Blow the balloon up as large as you safely can without popping it. Then pinch the neck so that no air can escape.*
5. *Stretch the neck of the balloon over the pop-top lid, being careful not to let any air escape. Carefully center the balloon's opening above the pop-top lid opening. Your hovercraft is now ready to do some hovering!*
6. *Tip: If the pop-top lid detaches from the CD and you used craft glue to glue them together, try carefully re-gluing them using super glue.*
7. *Place the hovercraft on a flat surface. Start your stopwatch or timer, open the pop-top lid, and push the hovercraft. Stop the stopwatch when the hovercraft stops hovering.*

   ***How long did the hovercraft hover for?***

8. *Detach the balloon from the pop-top lid.*
9. *Repeat this process two more times, blowing the balloon up as large as you safely can, attaching it to the pop-top lid, and timing how long the hovercraft hovers for. Did the hovercraft hover for the same amount of time each time, or was there some variation?*
10. *Repeat this process three more times, but this time only blow the balloon up to a medium size. For example, if it took three breaths to blow the balloon up as large as you safely could, use only two breaths or a little less to blow it up now.*

    ***How long did the hovercraft hover when the balloon was only a medium size? Did the hovercraft hover for about the same amount of time each of the three times you tested it using a medium-sized balloon?***

11. *Repeat this process three more times, but this time only blow the balloon up to a small size. For example, if it took three breaths to blow the balloon up as large as you safely could, use only one breath or less to blow it up now. How long did the hovercraft hover using a small-sized balloon? Did the hovercraft hover for about the same amount of time each of the three times you tested it using a small-sized balloon?*

    ***Overall, which size balloon allowed the hovercraft to hover for the longest amount of time? Which allowed it to hover for the shortest amount of time? Why do you think this happened?***

## WHAT HAPPENED?

*While modern hovercrafts often use propellers on top of the hovercraft to push air beneath the hovercraft, in this activity you used a balloon to do this instead of propellers. The air coming from the balloon traveled through the pop-top lid to go under the hovercraft. This means that while you tested balloons that were inflated to different sizes, because the pop-top lid stayed the same, the opening that allowed air to go beneath the hovercraft was always the same size. When the balloon was inflated to the largest size, it held the greatest amount of air and should have allowed the hovercraft to hover for the longest amount of time. Likewise, when the balloon was inflated to its smallest size, it held the least amount of air and so the hovercraft should have hovered for the least amount of time, and when the balloon was inflated to a medium size, it should hovered for an in-between amount of time. There may have been some variation (of just a few seconds) between the three trials because it is nearly impossible to fill the balloon with the same amount of air each time.*

# THE SCIENCE BEHIND IT

*Because a hovercraft is a vehicle that glides over a smooth surface by hovering upon an air cushion, it is also called an Air-Cushion Vehicle, or ACV. How is the air cushion made and how does it allow the vehicle to glide so freely? Vents or currents of slowly moving, low-pressure air are ejected downwards against the surface that is close below the hovercraft. In modern hovercrafts, propellers on top of the hovercraft often create the air currents and these are pushed beneath the hovercraft with the use of fans. Surrounding the base of the hovercraft is a flexible skirt, also called the curtain, which traps the air currents, keeping them right below the hovercraft. The trapped air currents can create an air cushion on any smooth surface, land or water! The air cushion greatly reduces the friction of the vehicle, allowing it to glide freely upon the smooth surface below.*

# EXTENSIONS

- *In this activity, you approximately made the balloon different sizes. However, you could more accurately measure the different balloon sizes and see how this correlates to the time the hovercraft hovers for. Repeat this activity but this time measure the circumference of the balloon each time and estimate the volume of air inside the balloon by calculating the volume of a sphere. Alternatively, you can use a water displacement method (dunk the filled balloon in a large metric measuring container and determine the change in height of the water) or an air displacement method (fill a large graduated cylinder with water in a large tub of water, invert the graduated cylinder under water so that the water in it does not escape, release the air from the balloon into the opening of the cylinder so that the air travels up into the cylinder, and then look at how much air is trapped in the cylinder). How does the volume of the balloon correlate with how long the hovercraft hovers for?*
- *Test the hovercraft on different surfaces. Which type of surface does the hovercraft work best on?*
- *Can you improve upon this hovercraft design? Think about features of this hovercraft you can change, such as the materials it is made from, the opening size of the lid, the hovercraft's shape, or its size. Could you add a curtain somehow to better contain the air cushion? Tip: Foam board cut into different shapes may work well instead of a CD or DVD. What modifications make the hovercraft hover even better? Can you use the action of a modified hovercraft for any practical purpose, or to solve a problem?*

# RESOURCES

*https://www.sciencebuddies.org/stem-activities/hovercraft?from=Blog#summary*

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