LESSON PLAN: Investigating Lift

The Tech Challenge 2019

Description:
During this science focused lesson, students explore the force of lift in a hovercraft and then create a labelled drawing to explain the forces involved in creating a working hovercraft.

Grade Levels:
6-8

Duration:
65-80 minutes

The Tech Challenge Connections:
- Students conduct experiments to learn and understand how a hovercraft works from a scientific perspective, which will help students gain background to The Tech Challenge 2019.
- Students draw a labelled drawing which will help students practice a necessary skill for their Tech Challenge Engineer's Notebook.

Objectives:
Students will
- Design experiments to test an idea.
- Conduct hands-on experimentation with a hovercraft to explore forces.
- Record hypotheses, observations, and labelled drawings to demonstrate their understanding.

Standards Connections:
NGSS MS-PS2-2
- Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Materials:

Hovercraft Materials (Makes 1 hovercraft)	(Optional Materials for step 5)	Each student needs the following

• 1 CD or DVD
• 1 Balloon
• Hot glue
• 1 Pop-up bottle top
	• Aquarium or clear plastic container that can hold water and is big enough for a CD hovercraft
	• Different surface materials:
	  ◦ Fabric
	  ◦ Aluminum
	  ◦ Short pile rug
	  ◦ Wax paper
	• Elevated table or angled board
		• Lab journal or paper
		• Diagram materials
		  ◦ Pencils
		  ◦ Rulers
		  ◦ Colored pencils
		  ◦ Erasers

Prep:
- Key scientific 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.
  - ◦ air pressure — The force exerted onto a surface by the weight of the air.
  - ◦ lift — The force transmitted through the pressure, which acts perpendicular to the surface of the airfoil.

- **Labelled Scientific Drawings.** This lesson includes asking students to create labelled scientific drawings. If this is not something your class has done before consider looking online or on YouTube for help. One option is: Scholle, Jeanne. "Rules for Scientific drawings". YouTube. 9 Jul. 2014. Web. 4 Sept. 2018. https://www.youtube.com/watch?v=HElwooECl2Y
- **Make Hovercrafts.** Make at least one per table or have students make the hovercrafts as part of the lesson (15 minutes). Instructions: https://www.youtube.com/watch?v=dy-61HV2FRw
- **Options for testing, demonstrating, or explaining scientific principles in this lesson (for educator reference):**
  - *What if my students want to test it on water?*
    "How can hovercrafts hover? | Live Experiments (Ep 8) | Head Squeeze". *BBC Earth Lab*, YouTube. 23 Feb. 2013. Web 4 Sept. 2018. https://www.youtube.com/watch?v=2a7z91KdaFE
  - *What if my students test it on something like carpet and it doesn't work?*
    Weight and air pressure are key to making any hovercraft work, so a little CD hovercraft with balloon air won't work in every situation. Another example of that is shown here where three hovercrafts are tested and the vinyl record doesn't work because it is too heavy:
    "Balloon Powered Hover Jet + D.I.Y CD hovercraft + D.I.Y vinyl record hovercraft". *GrandadIsAnOldMan*, YouTube. 10 Jun. 2014. Web. 4 Sept. 2018. https://www.youtube.com/watch?v=bqqVsIeHwgM&feature=youtu.be
  - *What if my students want to explore Bernoulli's principle?*
    "CD Balloon hovercraft hanging upside down... Bernoulli". PhysicsExperiments.org, YouTube. 29 Sept. 2016. Web. 4 Sept. 2018. https://www.youtube.com/watch?v=A4PpVMKvu50

Extensions:

- Calculate the lift force of different hovercrafts.
- "DiscoverHover CURRICULUM GUIDE #4: WHY A HOVERCRAFT HOVERS: PRESSURE AND LIFT". World Hovercraft Organization. 2004. Web 4 Sept. 2018. http://www.discoverhover.org/infoinstructors/guide4.htm

Lesson:

1. *In The Tech Challenge this year, students are going to create hovercrafts to solve a problem. Hovercrafts can be used in situations where the terrain is varied like wet, marshy land or along a beach and over water. Today we are going to explore how hovercrafts work* (5 minutes).
   a. Place a CD hovercraft on the table (without the balloon inflated) and ask students what the hovercraft is currently doing. (Answer: nothing.)
   b. *What forces are acting on the hovercraft currently?* (Answer: gravity is pushing the hovercraft down and the table is pushing the hovercraft up. The forces are balanced, so it is not doing anything.)
   c. *If we fill the balloon with air, what do you predict will happen?* (Possible answers include: nothing, the air will move it, the air will lift it.)
   d. Model how to fill the balloon with air and use the bottle cap to release the air.

2. (Optional) Make hovercrafts as a table team (15 minutes) or pass out hovercrafts (2 minutes).

3. Have each team observe their hovercrafts (10 minutes):
    a. Test moving the CD hovercraft with no air and then with air in the balloon.
    b. Record their observations and make a hypothesis as to why they think the CD hovercraft works the way it does in their notebooks or on a sheet of paper.

4. Discuss the observations the students made on their CD hovercraft test (5 minutes).
    a. Possible answers include: it moves easier with the balloon filled with air, there seemed to be less friction with air in the ballon, it moves a little around the table when there is air in the balloon.
    b. Why do you think that is? (Answers may vary.)
    *c. This CD hovercraft is a very basic hovercraft model, but it uses the same concepts as larger hovercrafts. The air from the balloon flows out the spout and along the CD back into the room. This focused flow (**air pressure**) of the air creates a small cushion of air that **lifts** the hovercraft off the table and thereby reduces the friction between the hovercraft and the table.*

5. Discuss and come up with ideas to test to help prove that hovercrafts are lifted by air. Then test one or multiple options as teams or as a class (15 minutes).
    a. How do we know that the hovercraft is being lifted by air? What could we do to prove that air pressure is creating lift for the hovercraft? (Answers will vary.) Have them brainstorm ideas.
    b. Have them test their ideas. For other tips and ideas on data collection in the classroom see Tech Tips: Collecting Data.
    c. Some options for testing, demonstrating, or explaining the science principles are shared in the Preparation Section of this lesson.

6. Share out, as a class, to debrief if and how the class' test helps prove that the hovercraft is lifted by air.
    a. Ask facilitative questions and conduct another experiment to refine theories:
        i. Describe your experiment.
        ii. What conclusion can you draw from your experiment about air pressure and lift?
        iii. What would you do next to explore hovercraft and the concept of lift? (Allow them to try another experiment if there is time.)
    b. Use students' data and conclusions to summarize what the students can tell from their experiments.
    c. Explain the science and how this applies to the students' experiments.

7. *At the beginning of class we discussed the CD hovercraft without air in the balloon and we decided the force of the table and the the force of gravity kept the hovercraft still on the table. Now that we know more about how a CD hovercraft works I want all of you to draw a labeled scientific diagram that shows the forces at play when the hovercraft has air released from the balloon* (30 minutes).
    a. Review your classroom's procedures for making a scientific drawing. For suggestions consider a video on this topic like the one suggested in the Preparation section of this lesson.
    b. Give students time to complete and turn in their drawings.