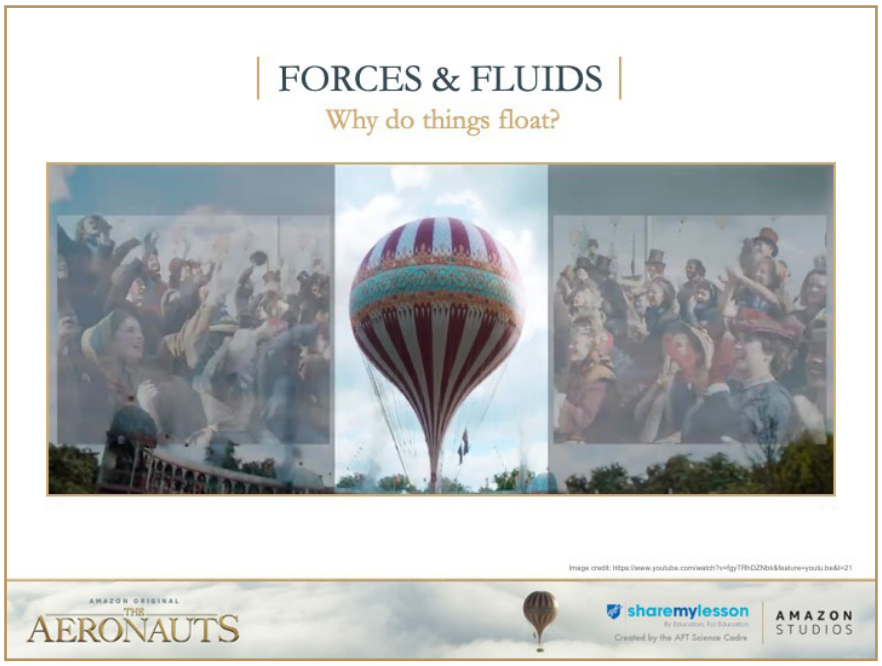
POWER POINT GUIDE: FORCES AND FLUIDS

SLIDE 1

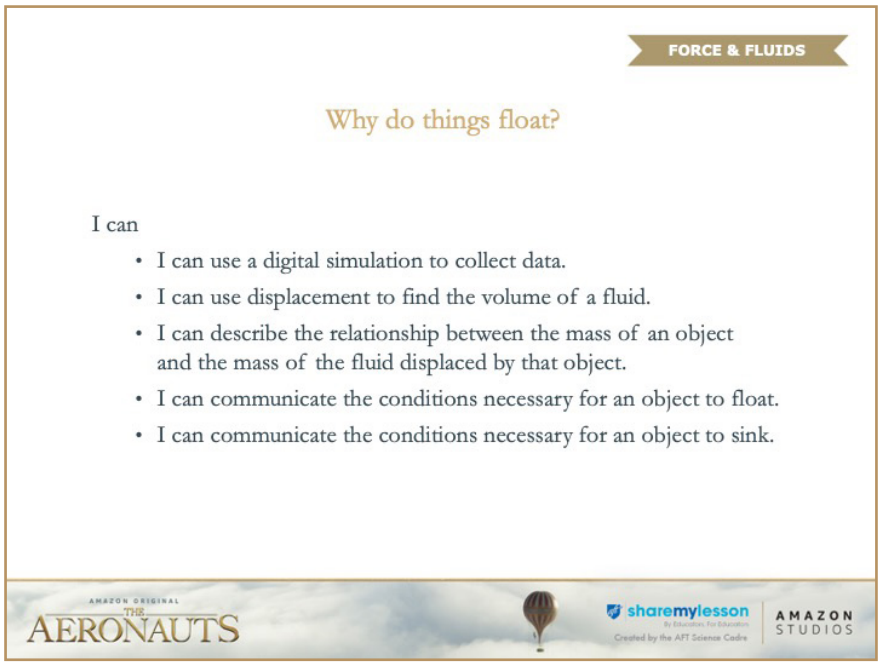


Show the movie trailer. (Click on image picture to link to movie trailer).
https://www.youtube.com/watch?v=Rm4VnwCtQO8

Ask students these questions following the trailer:

- What is an aeronaut? **The pilot or traveler in a balloon or other lighter-than-air aircraft.**[1] How do you know?
- What was the purpose of the flight? **To gather atmospheric data to be able to predict the weather**
- What type of balloon was used by the aeronauts? Students will probably say that the balloon was a hot air balloon. Ask them what they observed about the balloon that made them hypothesize that the balloon was a hot air balloon. Show the trailer again to allow students to observe there was no visible source of heat.
- What could the balloon be filled with to allow it to float? **Lighter-than-air gas like helium.**

[1] https://www.dictionary.com/browse/aeronaut



Have student volunteers read the learning targets for the lesson.


FORCE & FLUIDS
Why do things float?
Agenda
• Short pre-assessment
• Real world and career connections
• What are fluids?
• Use online simulating to gather data
• Analyze data and make a claim
• Forces that cause object to sink and float
• Whiteboard challenge
• Engineering Design Challenge and Balloon Festival
• History of aeronautics research OR
• Look at real balloon data to see what Glacier discovered about our atmosphere on his famous ascent.
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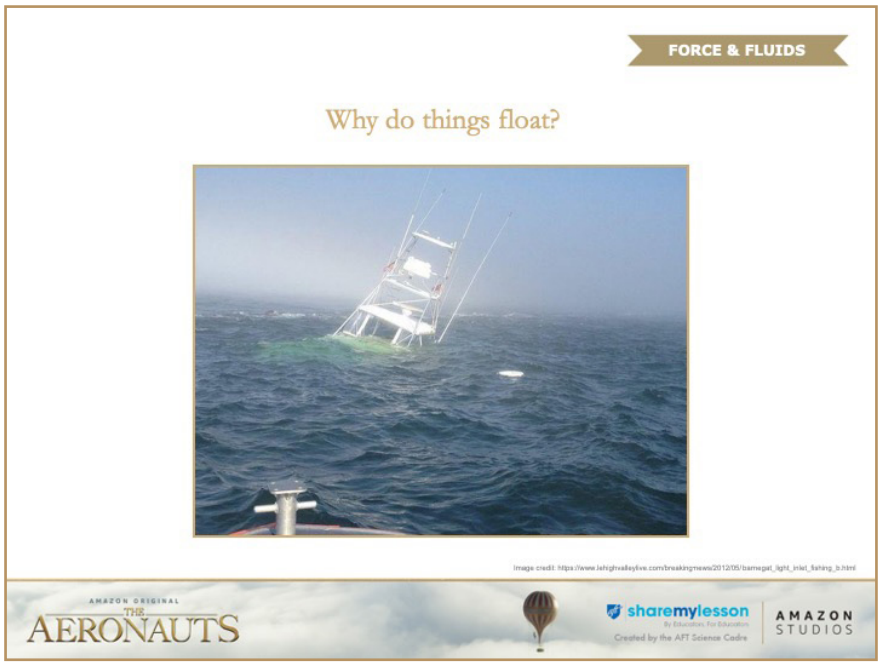
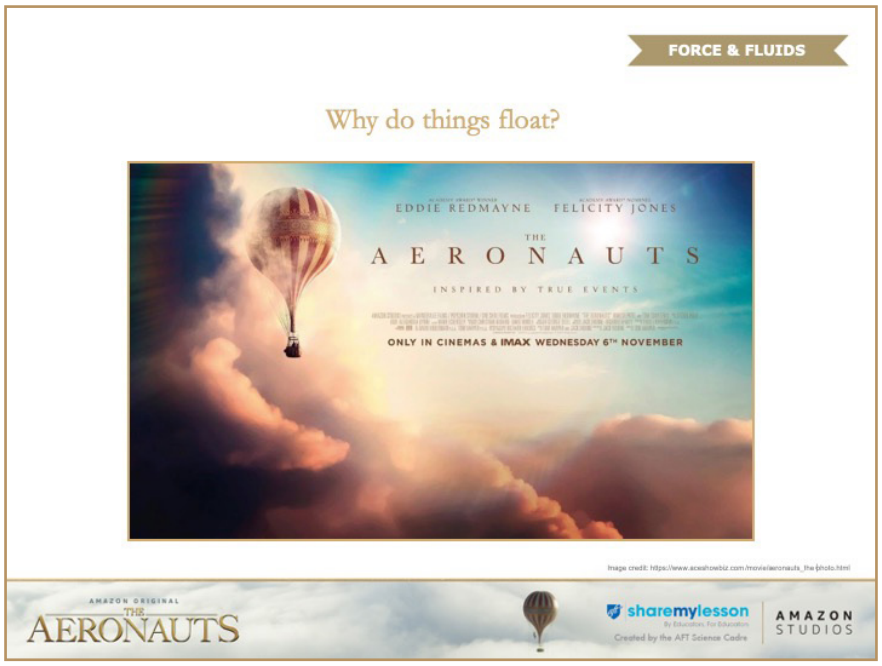
- Pre-assessment.
- Do your best.
- Answer every question.

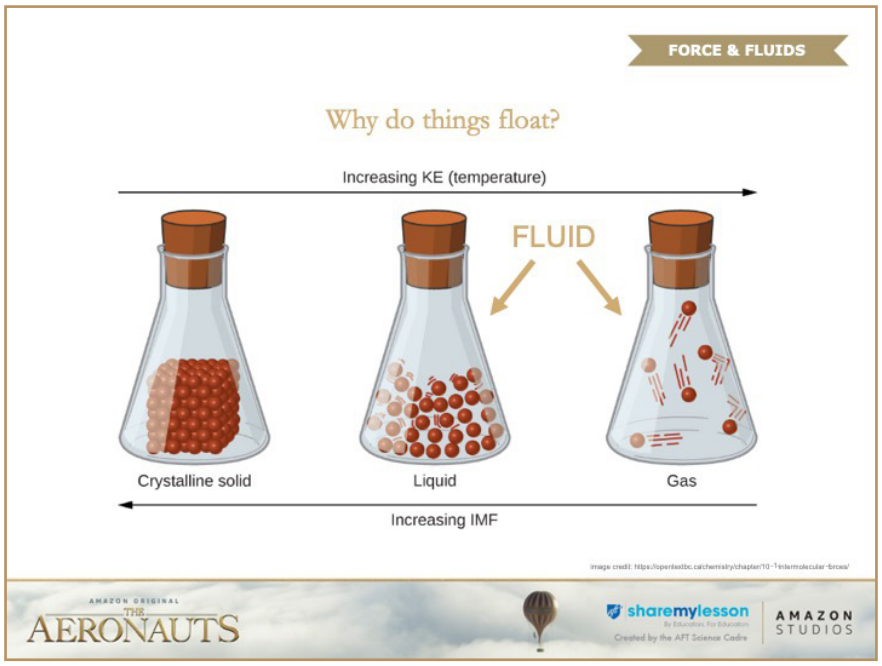
“Why is it important to know if an object will float or sink?”



Boating: you will want to understand when an unsafe load, or damage to a vessel will cause the boat to sink.



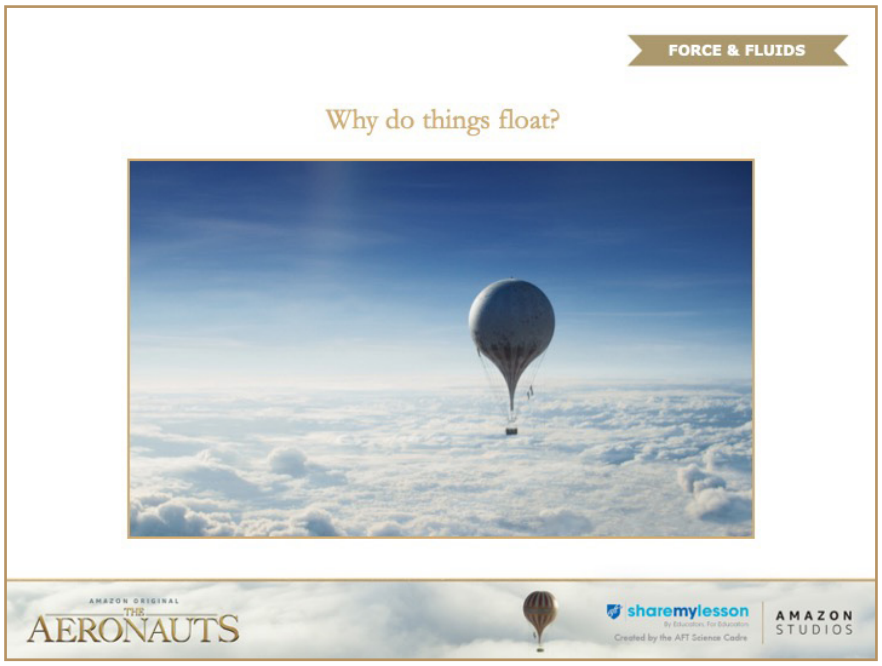
Aeronautics: to operate a balloon like the one used in the movie, an aeronaut needs to understand how to make the balloon float and sink.



- An object may sink or float when it is in the presence of a fluid.
- The three states of matter that are common on earth are **solid, liquid, and gas.**
- Liquids AND gases are considered fluids because they can flow.
- In liquids and gases, the forces between the molecules are weak enough that the molecules can move over or alongside one another[1], or flow.

- The state of matter depends on the strength of the forces between the molecules.
- An increase in temperature or pressure increases the kinetic energy of the molecules.
- In solids, the intermolecular forces between molecules are strong enough that the particles cannot move freely. Therefore, solids have a definite shape and volume.[2]

[1] https://www.scientificamerican.com/article/go-with-the-flow/
[2] https://courses.lumenlearning.com/boundless-chemistry/chapter/classification-of-matter/



In the movie, *The Aeronauts*, that object was the balloon. This includes the balloon, and everything inside and attached to it. The fluid was our atmosphere, which contains gases.

http://phet.colorado.edu/sims/html/gravity-force-lab/latest/gravity-force-lab_en.html

We are going to explore the conditions necessary that will cause objects to float and sink in fluids.*

We are going to explore these conditions using an online simulation:
http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT01/CT01.html

*Use the word "fluid" to describe the liquid in this simulation. This is building content knowledge that will help students understand the science behind their upcoming balloon engineering design challenge. Using the term "fluid" instead of water helps students understand that we are observing a phenomena that occurs in all fluids, including air, not just water.

Give the students time to play with the simulation and see what all they can manipulate.
http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT01/CT01.html

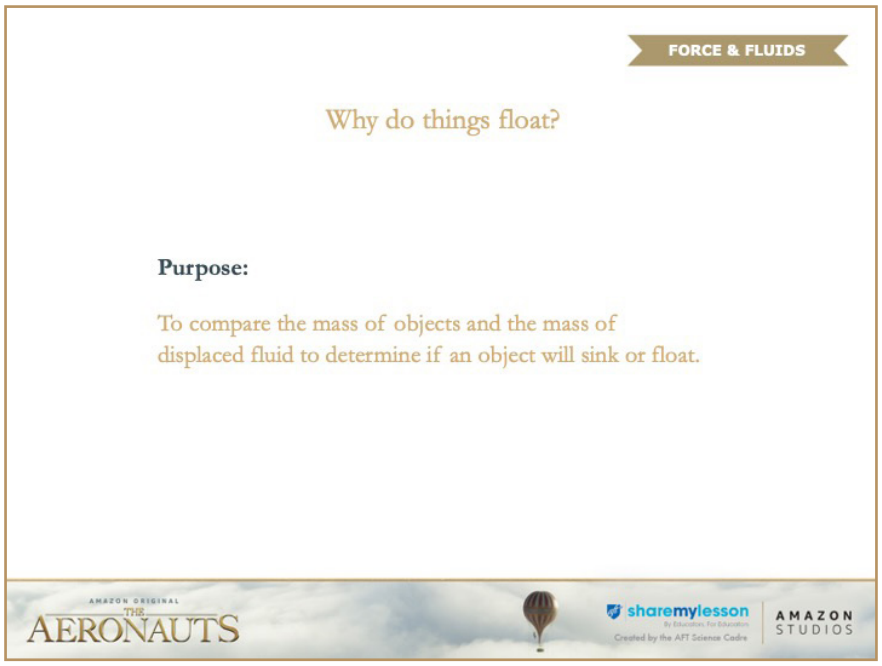
Do not encourage students to read the text to the left of the simulation. The goal of the activity is for students to construct their own content knowledge about why objects float or sink through inquiry, not learn why things sink or float by reading about it before the activity.

Make sure they know they can

- Drag objects to the electronic balance
- Read the mass of the objects on the electronic balance
- Drop the object into the can containing a fluid*
- Determine the volume of the object by measuring the amount of fluid displaced.
- How to remove the cover from the container containing the fluid to see if the object sinks or floats.
- How to test a different object (drag a new object to the balance)

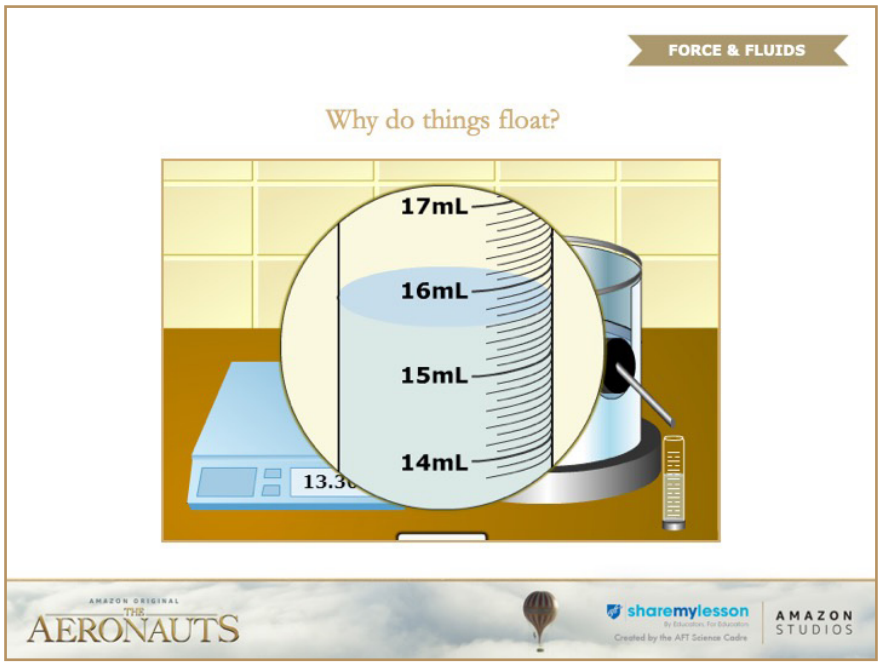
This simulation will allow us to see what conditions result in the object floating or sinking.

*Use the word "fluid" to describe the liquid in this simulation. This is building content knowledge that will help students understand the science behind their upcoming balloon engineering design challenge. Using the term "fluid" instead of water helps students understand that we are observing a phenomena that occurs in all fluids, including air, not just water.



"We are going to use this simulation to explore the forces that cause an object to sink or float within a fluid."

Pass out the lab sheet and instruct students to add the purpose to their lab recording sheet.



"To use the simulation to make this determination, we need to know the mass of the objects and the mass of the displaced liquid.

We already discovered how to determine the mass of the objects.

How do we determine the mass of the displaced fluid?

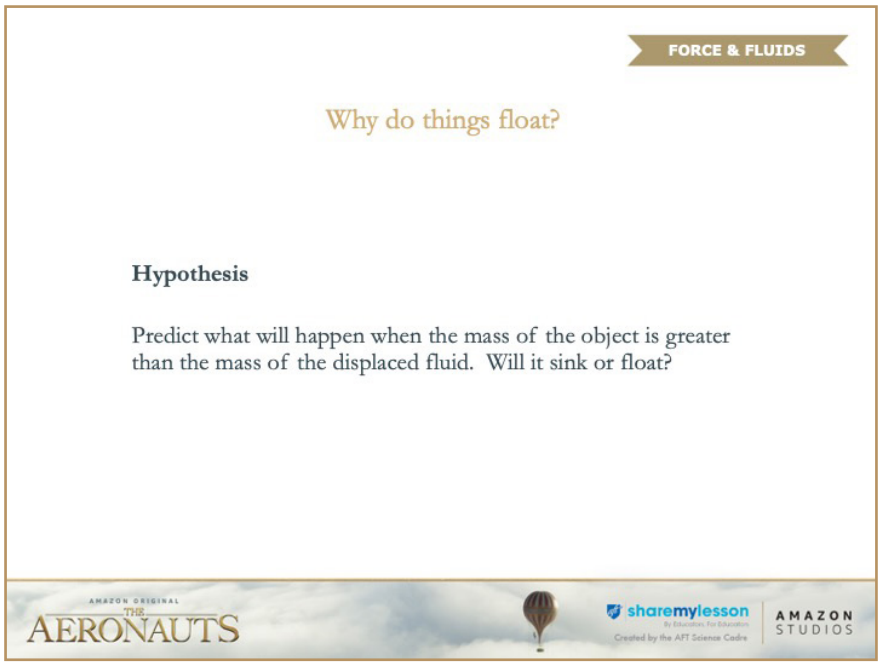
When an object is placed in the container, the fluid level rises. This is called displacement.

The displaced liquid spills out into a graduated cylinder. The reading on the graduated cylinder tells us the volume of the displaced fluid in mL.

One mL of *this* fluid has a mass of 1g.

If 25mL of fluid were displaced by an object, the mass of the displaced fluid would be 25g.

What is the mass of the displaced fluid in this picture?" 15.6g



Have students write their prediction in the hypothesis section of their lab recording worksheet.

An if/than hypothesis is a good technique.

An example of an if/than hypothesis is IF the mass of the object is greater than the mass of the displaced fluid, THAN the object will _____ (sink or float).

Help the students identify the variables.

INDEPENDENT VARIABLE

The independent variable is the one variable students are changing. In this experiment, we are changing the relationship between the mass of the object and the mass of the displaced fluid. Students may think the objects are the independent variable, HOWEVER those objects are the tools we are using to create different mass of object/mass of displaced fluid combinations.

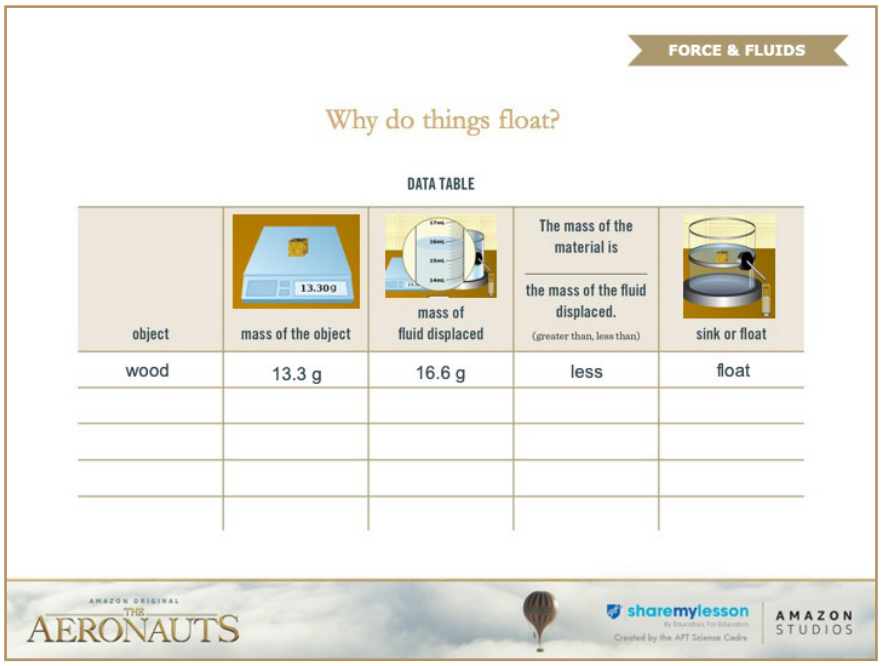
DEPENDENT VARIABLE

The dependent variable is usually what comes after the THAN an IF/THAN hypothesis. In this case the students predicted whether the object would float or sink so weather the object floats or sinks is the dependent variable.

CONSTANT VARIABLES

Constant variables are the factors that are kept the same. The only thing that is changed is the objects.

Students may question why different objects are used. They may think that different sizes of the same object (like different size wood blocks) or objects that are the same size but different mass (like blocks made of different materials) would be a fairer test. Let students know that because the independent variable is the relationship between the mass of the object and the mass of the displaced fluid, it does not matter what the object is. Using different objects or different size objects gives us different volumes of fluid displacement and different masses which will ultimately provide the best evidence to answer our question. Additionally, using different volumes of fluid gives us practice using the graduated cylinder to determine volume of fluid displaced.



"As you do the experiment, for each object, record the mass of the object as shown by the electronic balance.

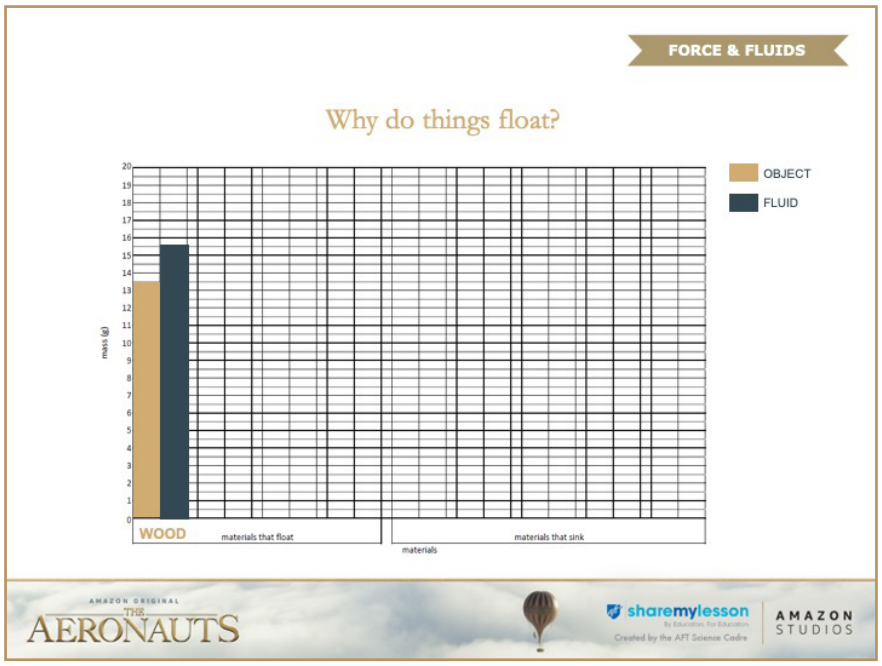
The mass of the displaced fluid as determined by the number of mL of displaced fluid.

Remember, 1mL = 1g.

In the fourth column, complete the sentence with the word greater or less to describe the relationship between the mass of the object and the mass of the displaced fluid.

In the final column, record if the object sinks or floats."

For students that need additional support and direction, use the animation to walk them through an example.

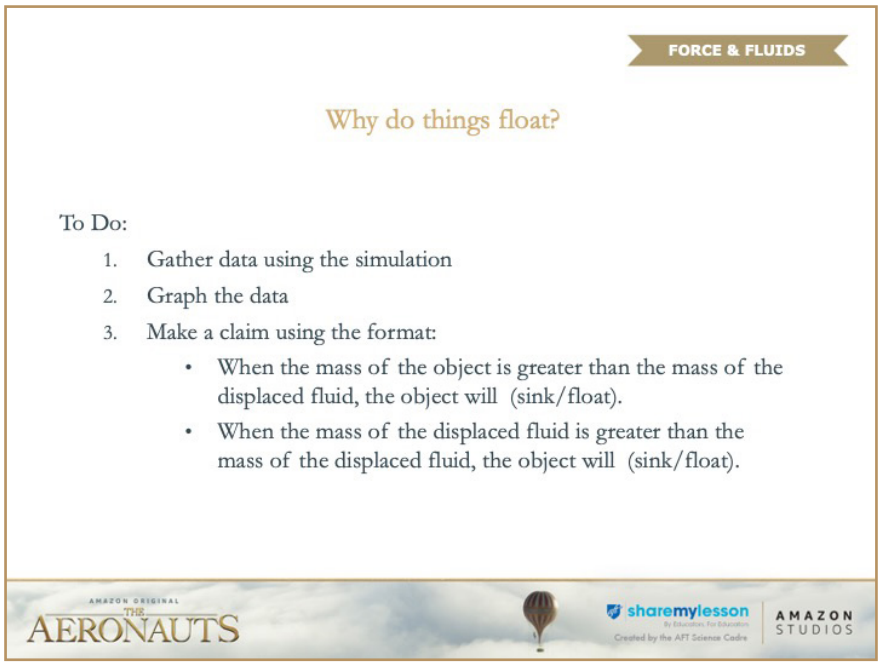


“Graph your data using this bar graph. Graph all the object that float on the left side of the graph, graph the objects that sink on the right side of the bar graph.

For each object tested, make one bar to communicate the mass of the object and another bar to communicate the mass of the displaced fluid.

Create a key to communicate which color represents objects and which color represents fluid.”

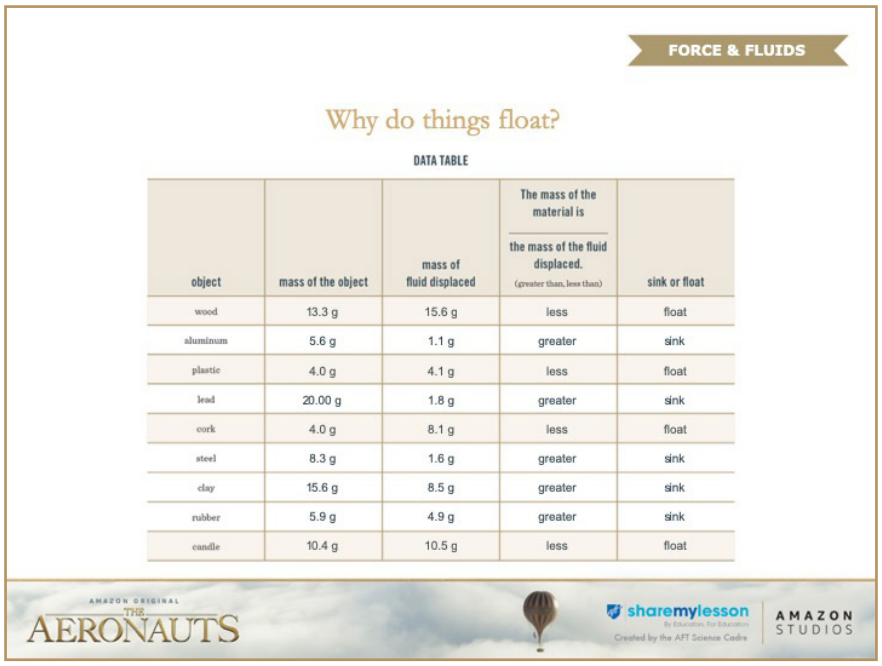
Use the animations to show students how to graph the results of the wood block.



Give students time to work. Project this slide while they work. After students are finished graphing their data, they are to look at their data and make a claim.

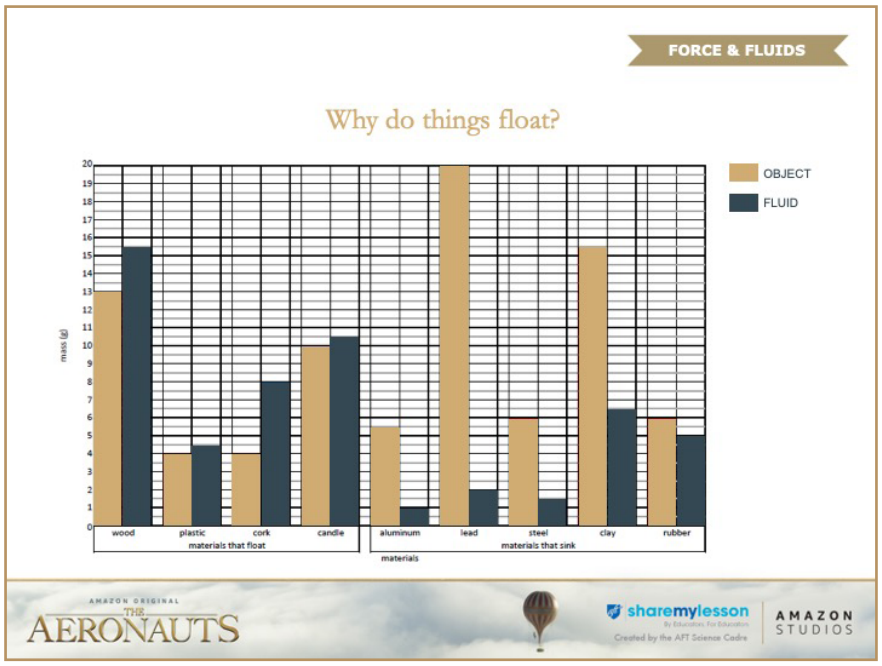
To make the claim, have students look at the data recorded in your data table and the bar graph. What are the trends? What is the relationship between the mass of the object and the mass of the displaced fluid for the objects that float? What is the relationship between the masses for all the objects that sank?

Make the claim using the format to summarize those relationships.



Use a document camera to project one of the student's data tables to discuss the results. If you don't have a document camera, use this slide.

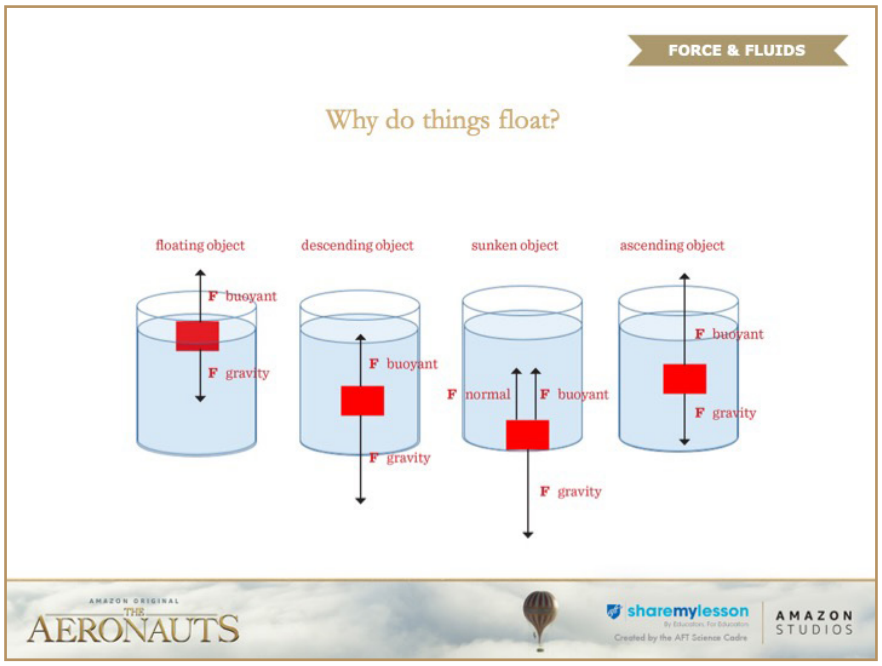
"What patterns and trends did you notice in the table?" Every time the mass of the object was less than the mass of the displaced fluid, the object floats. Every time the mass of the object is greater than the mass of displaced fluid, the object sinks.



Use a document camera to project a student's graph. If you don't have a document camera, use this slide.**

- What color represents the objects? **Gold**
- What color represents the displaced fluid? **Blue**
- What does the height of the bars communicate? **Mass of the objects or displaced fluid.**
- For ALL the objects that float, what do you notice about the height of the red and blue bars? **All the blue bars are taller than the red bars.**
- What does this tell us about the relationship between the mass of the object and the mass of the displaced fluid when objects float? **The mass of the object is less than the mass of the displaced fluid when objects float.**
- For ALL the objects that sink, what do you notice about the height of the red and blue bars? **All the gold bars are taller than the blue bars.**
- What does this tell us about the relationship between the mass of the object and the mass of the displaced fluid when objects float? **The mass of the object is greater than the mass of the displaced fluid when objects float.**

**Due to limitations of technology, the height of the bars in this example graph do not exactly represent values from the simulation.



Guide the class to draw force diagrams to explain the forces acting on objects as they float and sink.

- Label the first container, **floating object.**
- Looking at the simulation, was the floating object moving? **No**
- What does that tell us about the forces acting on the object? **They were balanced**
- The force that keeps the object floating is called the buoyant force. Draw an upward arrow to represent the buoyant force acting on the object.
- What would be the downward force acting on the object? **Gravity**
- Draw a downward arrow that represents the force of gravity. It is important that the size of the arrows are the same to represent the fact that the size (magnitude) of the buoyant force is the same as the size (magnitude) of the force of gravity.

In the simulation, we did not see what happened right after we dropped the object in the container. We lifted the cover of the container and saw that the object was floating or had sank.

- Picture for a second, the cover removed, and we could see the object descending to the bottom of the container.
- Label the second container, **descending object.**
- What does this change in motion tell us about the forces acting on the object? **Not balanced**
- What direction was the object moving as it was descending? **Downward**
- What does that tell us about the magnitude of the force of gravity compared to the buoyant force? **Force of gravity was stronger than the buoyant force.**

- How can we draw our arrows to represent this? **Arrow that shows the size of the force of gravity is longer than the arrow that shows the size of the buoyant force.**

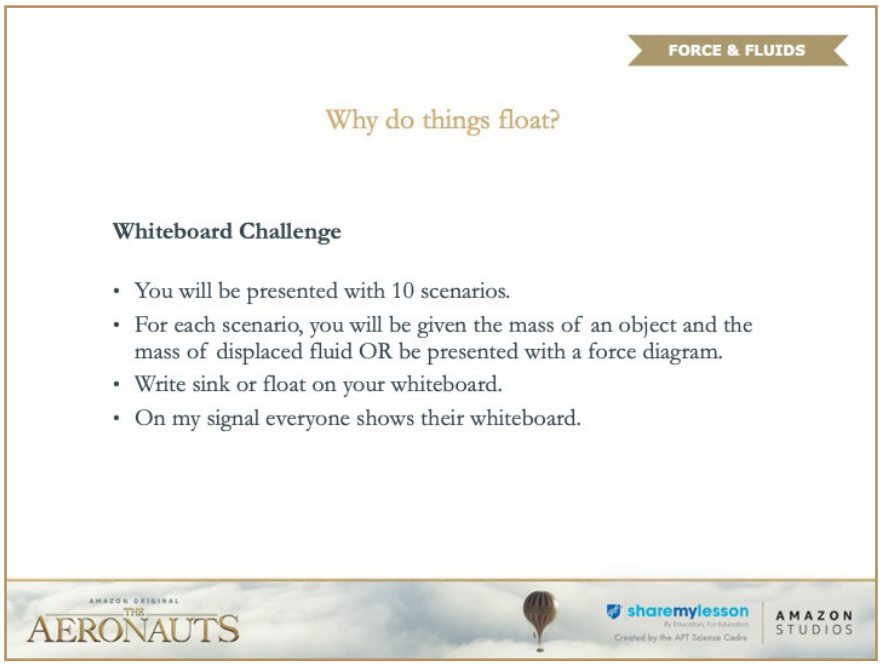
Label the third container, **sunken object.**

- Is the object moving? **No**
- What does that tell us about the forces acting on the object? **The forces are balanced.**
- Draw your downward arrow to represent the force of gravity.
- The block is partially supported by the fluid when it is submerged, therefore the buoyant force is still acting on the object[1] BUT the object is also in contact with the surface of the container. The surface of the container is also supporting the object. What force is present when two objects are in contact in this way? **Normal force**
- The normal force and the buoyant force both act in upward directions. The strength of these two forces together is the same as the strength of the gravitational force. Draw two arrows pointing upward showing the normal force and the buoyant force. The length of both arrows, if stacked on top of each other, should be equal the length of the arrow that represents the force of gravity. This communicates that the upward forces and the downward forces are equal in magnitude.

Finally, let's pretend that we took a floating object and pushed it to the bottom of the container.

- What would happen when we released the object? **It would ascend.** (If the students don't use the term ascend, introduce them to this term because this is the term associated with ballooning.)
- What does this change in motion tell us about the forces acting on the object? **Not balanced**
- What direction was the object moving as it was ascending? **Upward**
- What does that tell us about the magnitude of the buoyant force compared to the force of gravity? **The buoyant force was stronger than the force of gravity.**
- How can we draw our arrows to represent this? **Arrow that shows the size of the buoyant force is longer than the arrow that shows the size of the force of gravity.**

[1] https://opentextbc.ca/physicstestbook2/chapter/archimedes-principle/


FORCE & FLUIDS
Why do things float?
Whiteboard Challenge
• You will be presented with 10 scenarios.
• For each scenario, you will be given the mass of an object and the mass of displaced fluid OR be presented with a force diagram.
• Write sink or float on your whiteboard.
• On my signal everyone shows their whiteboard.
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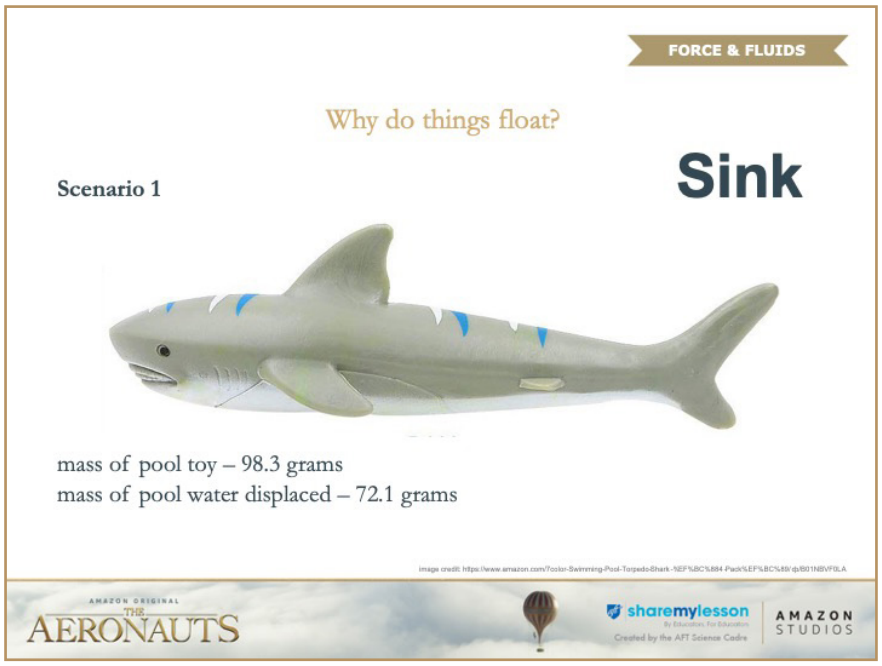
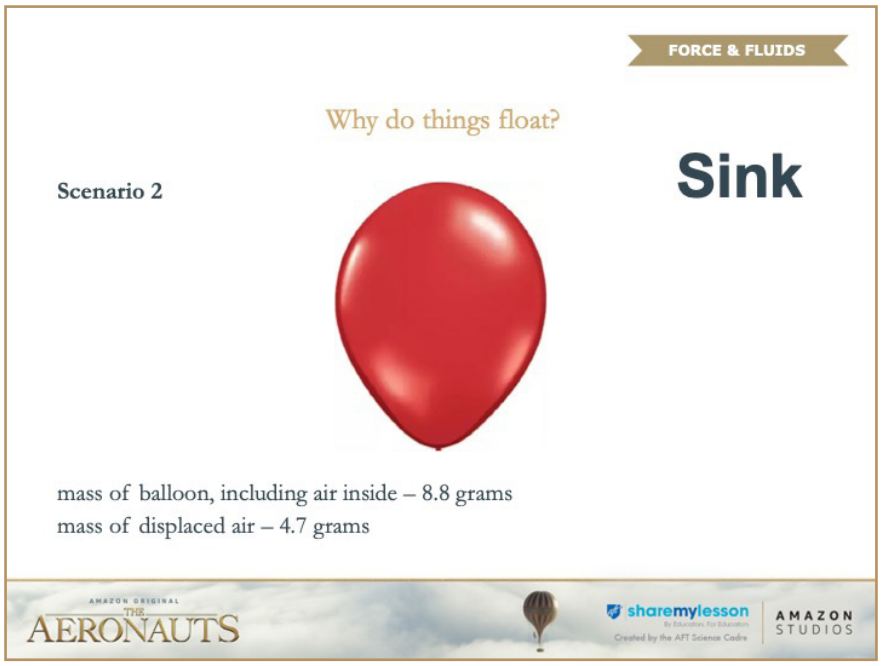


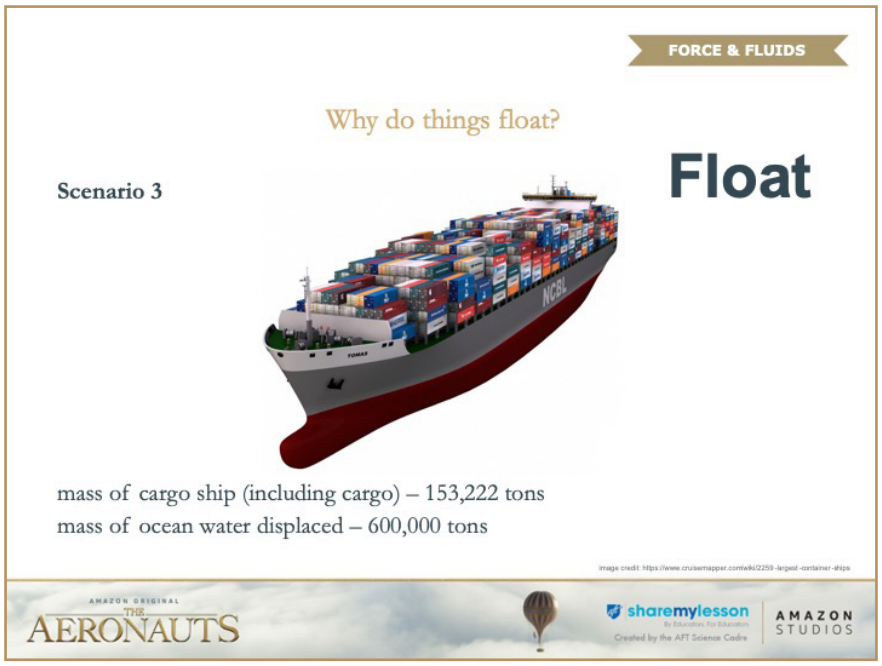
Pool toy

- Sink – the mass of the pool toy is greater than the mass of the displaced water



A child is holding this balloon. The child lets go.

- Sink – the mass of the balloon is greater than the mass of the displaced air

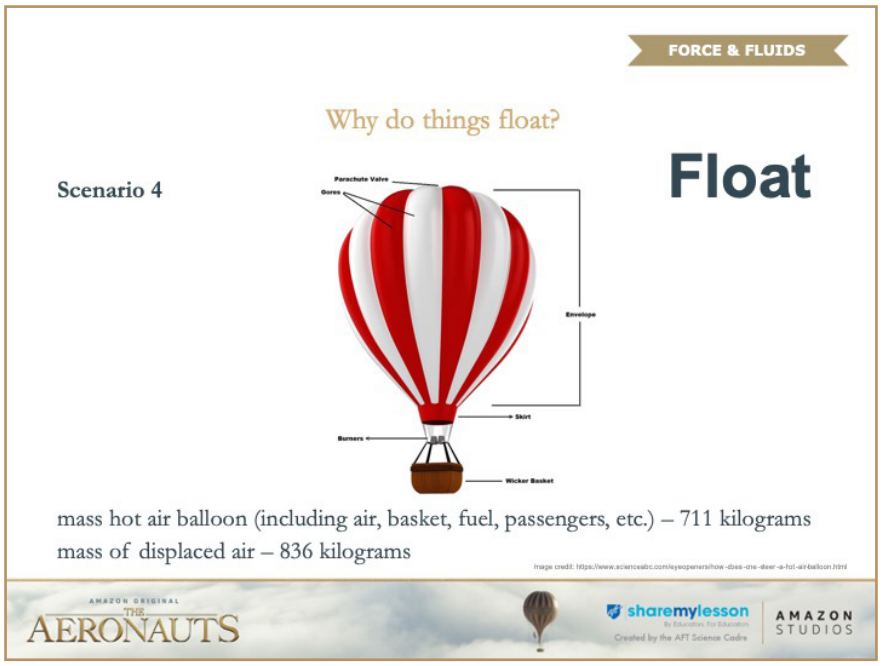


A shipyard is building this cargo ship. It is estimated that the mass of the ship, including cargo will be 153,222 tons.

The mass of water displaced by the fully loaded ship will be 600,000 tons.

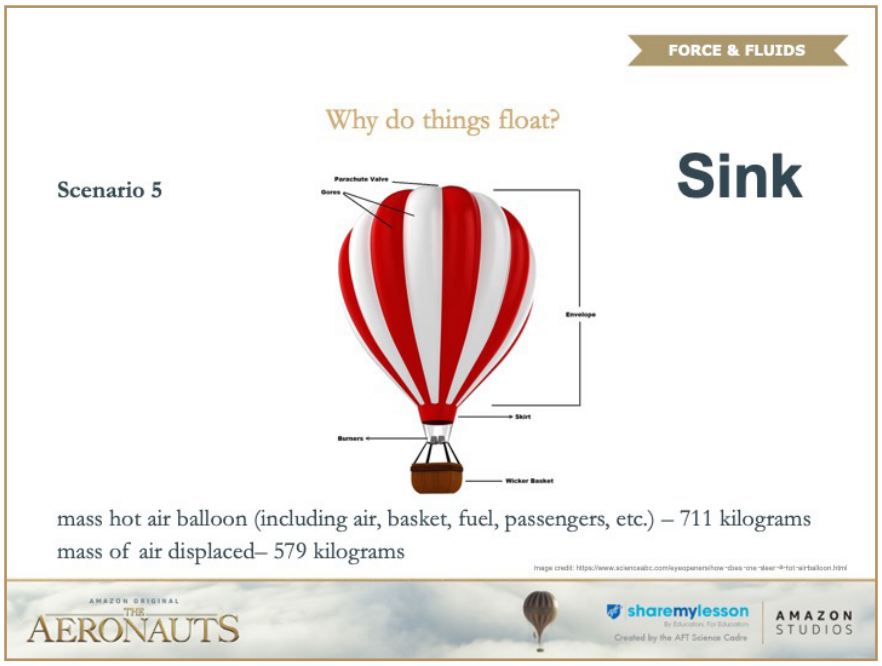
Will this ship sink or float?

- Float – mass of ocean water is greater than the mass of the boat



This hot air balloon is flying at an altitude of 1,000 ft.

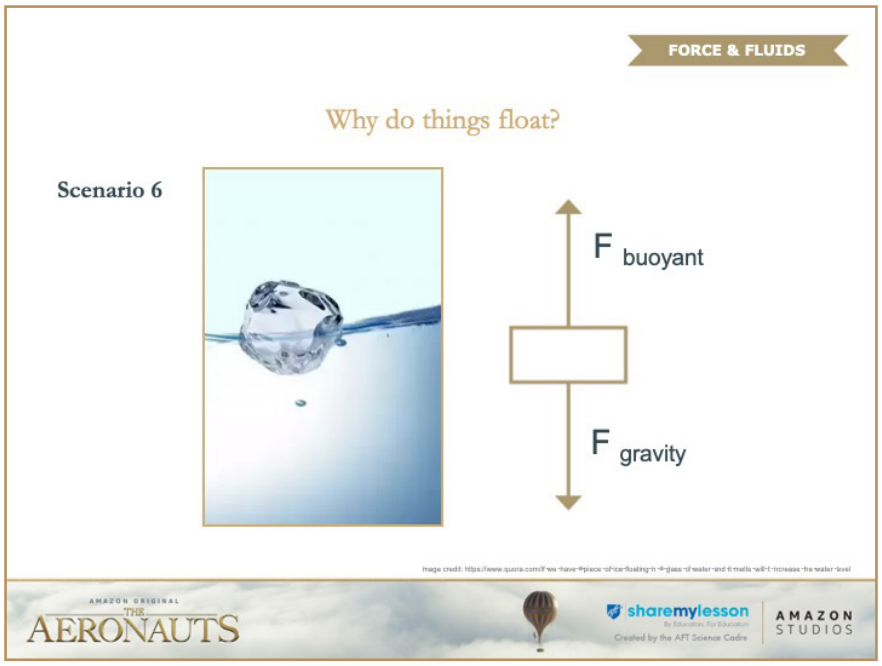
Will this hot air balloon sink or float? **Float**



This same hot air balloon is flying at an altitude of 3,000 ft.

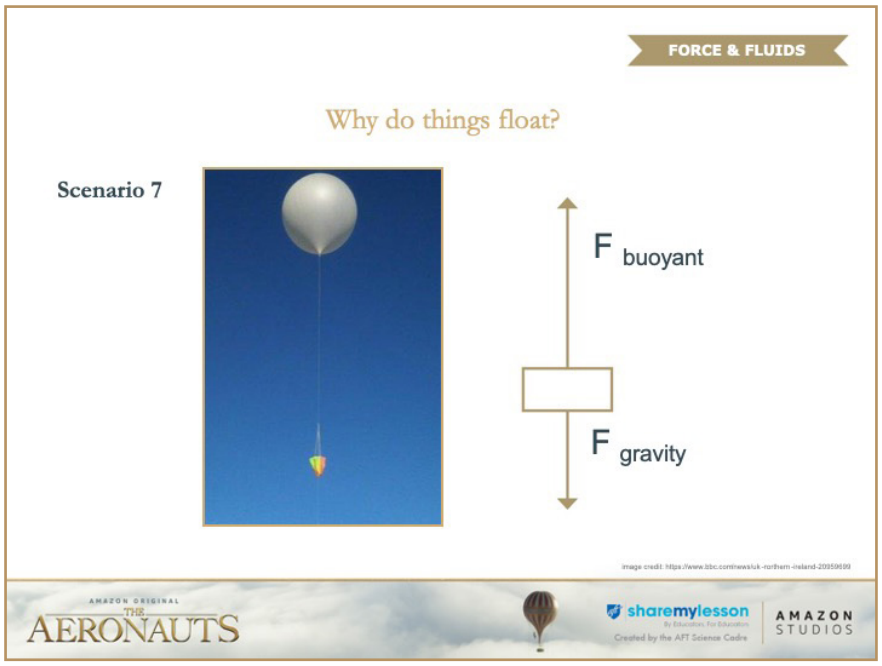
Will this hot air balloon sink or float? **It will sink**

The density of the air decreases as altitude decreases. The same balloon that floats at a lower altitude will not be able to float at a higher altitude.



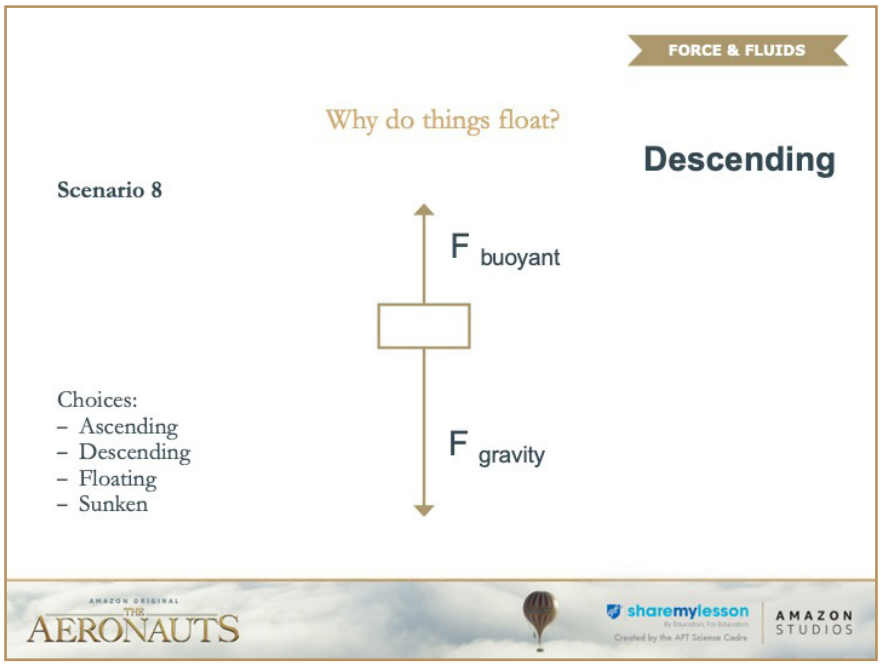
Draw force diagrams that shows the forces acting on an ice cube floating in water.

If the ice cube is floating at the top of the water, the ice cube is not moving up or down. The buoyant force and the gravitational force are balanced.

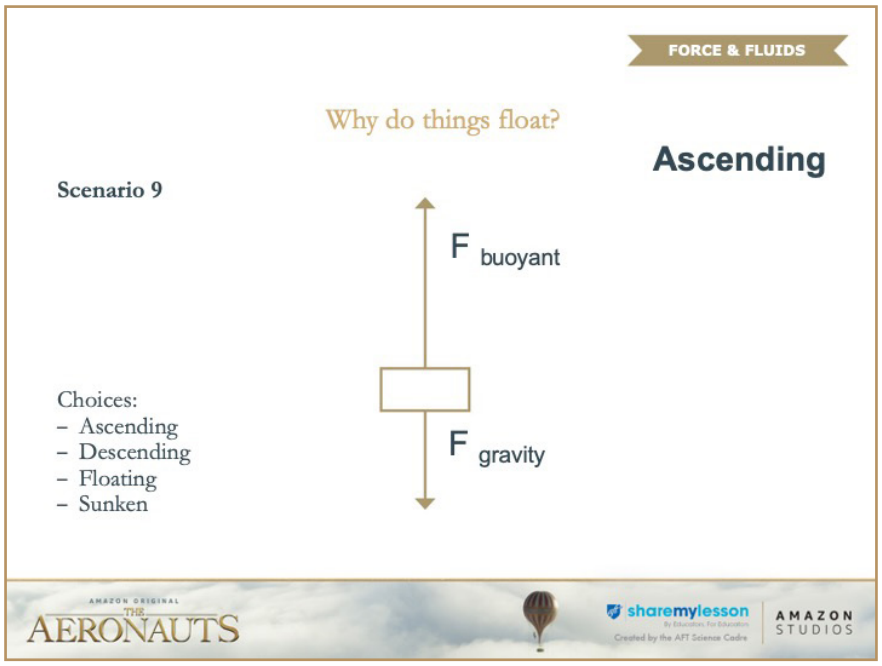


Draw force diagrams that shows the forces acting on this weather balloon that is ascending.

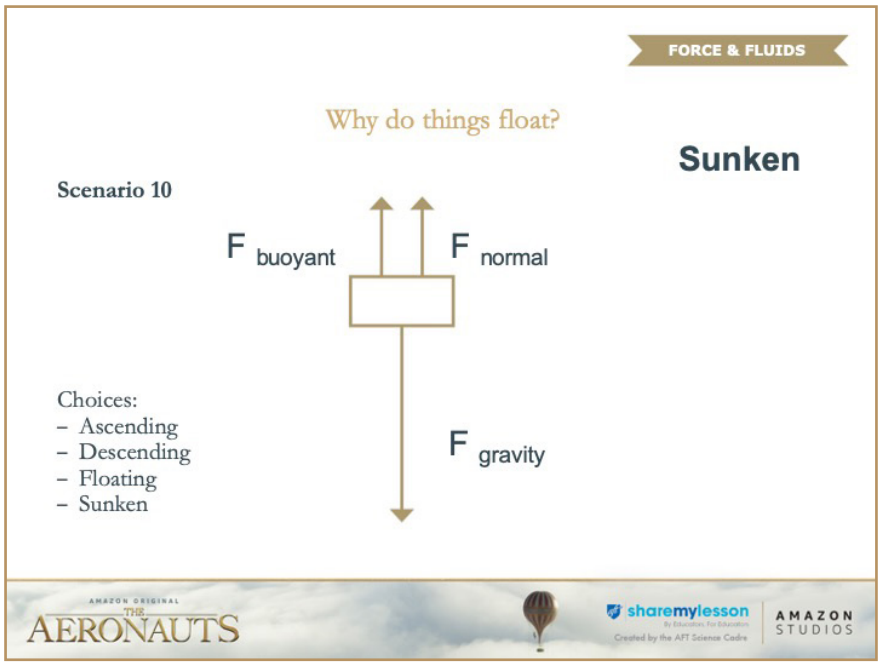
If the balloon is ascending, the buoyant force is stronger than the force of gravity, so the balloon is ascending (and accelerating) upward.



The force of gravity is stronger than the buoyant force. This object will be descending (and accelerating) downward.



The buoyant force is stronger than the force of gravity. This object will be ascending (and accelerating) upward.



The buoyant force and the normal force equal the force of gravity.

Because the normal force is present, we can tell the object is in contact with another object.

Because the buoyant force and normal force added together are the same size as the force of gravity, the forces are balanced.

The best choice under these conditions is sunken.