The Science of Hot Air Balloons

Grade Range: Elementary School

Lesson Time: 40 minutes

Key Terms	
Archimedes' Principle	Molecules
Buoyancy	Thermal energy
Density	
Displaced	
Gravity	
Matter	

Materials and Resources
K-W-L Chart

Activity Overview

Up, up, and away with the science of hot air balloons! Have you ever seen a hot air balloon and wondered how it can fly in the sky? Hot air balloons are not like aircraft that have an engine, so how do they rise up from the ground? It is all about air! In this activity, students will describe how matter is made up of particles too small to be seen, compare the characteristics of matter before and after thermal energy is added, and identify the relationship between buoyancy and density.

Essential Questions

1. How can one explain the structure, properties, and interactions of matter?
2. How do particles combine to form the variety of matter one observes?

Objectives

- Describe how matter is made up of particles too small to be seen
- Compare the characteristics of matter before and after thermal energy is added
- Identify the relationship between buoyancy and density

Introduction

To begin this activity, pair up the students and hand each student a K-W-L Chart. Ask students to fill in the K column with all of the facts they know about hot air balloons. Have the student pairs share what they know about hot air balloons with the rest of the class. After the class discussion, give students a few minutes to write down their W (wonder) questions. (Students will complete the "What I Learned" part of the chart to close this activity.) Most students at this age are vaguely familiar with hot air balloons from movies or books, so explain that today they will learn the science behind how hot air balloons are able to float in the sky. Tell students that they are now going to learn about aerostats—hot air balloons that are lighter than aircraft.

zSpace Activity

Activity Questions Provided in StudioA3

Answers may vary. Sample answers are provided below.

1. You may have seen a hot air balloon and wondered how it can fly in the sky. Hot air balloons are not like aircraft that have an engine, so how do they rise up from the ground? It is all about air! What do you know about air?
   Air is matter in the gaseous state.
2. Air is matter in the gaseous state. Matter is what makes up everything and takes up space. It can come in three states. What are these three states of matter?
   The three states of matter are solid, liquid, and gas.
3. The three states of matter are solid, liquid, and gas. Matter is made of molecules. What are molecules?
   Molecules are two or more atoms tightly packed together.
4. Molecules are two or more atoms tightly packed together. In the case of the hot air balloon, these tiny air particles are both inside and outside of the balloon. While the balloon is sitting on the ground, the air molecules are the same temperature and are moving within and around the balloon at the same speed. How do you think we could change the speed of the air molecules inside the balloon?
   We could change the speed of the air molecules inside the balloon by adding thermal energy, or heat.
5. We could change the speed of the air molecules inside the balloon by adding thermal energy, or heat. The hot air balloon pilot can turn on a propane flame under the opening of the balloon. This flame heats up the air inside the balloon. When the air molecules get warmer, they start to move around more quickly and spread out. What happens to the balloon when the pilot turns on the flame?
   When the pilot turns on the flame, the balloon will rise in the air.
6. When the pilot turns on the flame, the balloon will rise in the air because hot air rises. The warmer molecules inside the balloon are less dense than the cooler molecules in the air outside of the balloon. What does less dense mean in this sentence?
   Less dense in this sentence means that the warmer molecules inside the balloon are lighter than the cooler molecules in the air outside of the balloon.
7. “Less dense” means the warmer molecules inside the balloon are lighter than the cooler molecules outside of the balloon, which will make the balloon rise in the air. If the air in the balloon were more dense than the air outside of the balloon, the balloon would sink back to the ground. Just like objects that float or sink in water, the hot air balloon rises and sinks, controlled by the same forces. Which of these forces cause objects to float or rise upward? A.) Gravity B.) Buoyancy C.) Magnetism
   B.) Buoyancy
8. Buoyancy is the force that causes objects to float or rise upward. Have you ever heard of Archimedes' Principle? It states that the buoyant force acting on an object in water is equal to the weight of the displaced fluid. That means the strength of an object’s buoyancy depends on how much water that object displaces. The more water that is displaced, the stronger the buoyant force is, and if the gravitational force is less than the buoyant force then the object floats. This can be applied to both boats floating in liquids and hot air balloons floating in gases. What does the word “displace” mean?
   The word “displace” means to forcibly move something out of the way so that something else can take its place. In the case of liquids, when an object is placed into a container of water it will displace the water to make room for the object in the water.
9. The word “displace” means to forcibly move something out of the way so that something else can take its place. In the case of liquids, when an object is placed into a container of water it will displace the water to make room

for the object in the water. Open the model gallery and create a real-world example of buoyancy. Take a photo of your completed scene.
Photo: Example of buoyancy such as a boat floating on water or a hot air balloon flying in the sky.

10. Hot air always rises and cold air sinks. Look at the house in this scene and notice that it is winter time. Move the text boxes next to the correct arrow to label where the warmer and cooler air would be found in this house. Take a photo of your completed scene.
Photo: Warmer air at the top of the house. Cooler air at the bottom of the house.
11. Did your completed house look like this one? Good! The best time to take a hot air balloon ride is in the morning, around sunrise. Why do you think hot air balloons launch so early in the morning?
Hot air balloons launch so early in the morning because the temperatures are cooler than later in the day and the winds are more calm.
12. Hot air balloons launch so early in the morning because the temperatures are cooler than later in the day and the winds are more calm. In warmer temperatures, the balloon has to be heated even more in order to compensate for the warmer outside air. When the balloon needs to land, what must happen?
When the balloon needs to land, the heat must be removed so that the air in the balloon can become cooler.
13. When the balloon needs to land, the heat must be removed so that the air in the balloon can become cooler. Which of these forces will help the pilot land the hot air balloon? A.) Gravity B.) Buoyancy C.) Magnetism
A.) Gravity
14. As the warmer air molecules inside the balloon cool down, they become denser and the balloon starts to sink back to the ground. What does the word “denser” mean in this sentence?
The word “denser” in this sentence means that the cooler molecules inside the balloon are heavier now and the balloon starts to sink to the ground.
15. Which of the following statements is not true? A.) Air is more dense when cooled. B.) Warmer molecules contract. C.) Density affects buoyancy. D.) Heated molecules move quickly.
B.) Warmer molecules contract.

Closing

To close this activity, have students work with their partners to fill in the L (learned) column on their individual K-W-L Charts with what they learned about hot air balloons from today’s activity. As a class, review and discuss in detail what they learned about hot air balloons, buoyancy, and density.

Differentiation

- Group students heterogeneously to allow students with a strong command of the English language to assist in reading or interpreting questions
- Provide paper copies of diagrams for students to use as a reference
- Provide a handout with a list of vocabulary terms and definitions that will appear in the activity
- Allow students to provide answers that are handwritten, typed, or verbal
- Give students a variety of presentation styles to choose from (using charts/graphs, PowerPoint, making 3D presentations, creating videos/movies, making posters)
- Have students work as partners or in small groups (younger children could partner with older buddies)
- Enrichment: Students could change an additional variable in the activity and look for patterns
- Enrichment: Students could find real-world problems involving the concept and design solutions to those problems

- Enrichment: Students could research similar topics and create presentations
- Enrichment: Students could build a model of a key concept

Resources

Beatty, Karla. “Molecules in a Hot Air Balloon.” *Dreamstime,* https://www.dreamstime.com/warmer-molecules-inside-balloon-denser-than-cooler-molecules-air-outside-balloon-hot-air-rises-image121516457.

Designua. “Archimedes Principle.” *Dreamstime,* https://www.dreamstime.com/stock-photography-archimedes-principle-buoyant-force-acting-object-equal-to-weight-displaced-fluid-image37211092.

Designua. “Density and Lever.” *Dreamstime,* https://www.dreamstime.com/density-lever-density-lever-demonstrated-density-two-objects-comparing-mass-equal-volumes-vector-illustration-image249276999.