THE STUDY OF HELIUM BALLOONS

Preston Coates
Cary Academy

ABSTRACT
The purpose of this study was to find if heating a balloon would change its flight performance. Helium is a gas that is very unique, being the only element found in space before on earth. After putting the balloon in the incubator for an amount of time, the balloon was placed on the ground and let go with the start of a stopwatch and timed until the balloon hit the ceiling. The longer the balloon was left in the incubator, the shorter time it took to hit the ceiling. This happens because the helium inside of the balloon is heated and makes the helium rise faster.

INTRODUCTION

“Dense” means thick, solid, compact, or condensed and is derived from the Greek root word dasus. The denseness or density of elements is variable. Iridium is one of the densest elements while lithium is one of the least dense. Helium’s density (in kg/m$^3$) is 0.1664. Density is defined as an amount of matter or mass within a given volume or space. Density relates to mass. Something that contains more mass than another has more density than the other if their volumes or areas are similar. Using water, people can determine if the object will float or sink according to its relative density. Therefore, things that are less dense than water will float. However, somehow some things that are more dense than water float. One example is the large battleship. Steel is obviously denser than water, so it should sink. The only reason large steel ships do not sink is because they are filled mostly with air, which is less dense than water, so they float. The density of all elements increases as the object turns from a gas to a liquid to a solid. The only exception of that rule is water. Water follows this rule in the gas form, but breaks the rule when the densest form of water is found. The densest form of water is its liquid form. Next is the solid (ice) and last the gas form (steam). The difference is that the molecules of the different forms are differently packed. Solid’s molecules are tightly packed, so the molecules don’t have room to change shape or volume. Liquid’s molecules are less tightly packed, so they are free to change to
any shape (Note: not volume) that it is held in. Gas’ molecules are so free to roam that they can change into any shape or volume! The atomic mass of helium is $4.002602 \pm 0.000002$ u.

Figure 1. A diagram of the difference of the molecules of the different states of matter.

Helium was discovered in 1898 by Pierre Janssen and Norman Lockyer. They discovered helium during a solar eclipse when they saw a spectral line that didn’t exist on the Periodic Table. They saw that it was coming from the sun, so they named it helium after the Greek word for sun, Helios. Since then it has become a great help for current problems. They put helium into air balloons to carry people into the sky. People used to use hydrogen, which is extremely flammable, but stopped after the infamous explosion of the air ship, The Hindenburg. They also put helium into divers’ oxygen tanks to keep them breathing. Also, helium helps prevent “The Bends”, which happen when deep sea divers rise to the surface of the water. Helium is the second most abundant element and the only element to have been discovered in space before on Earth. Helium’s molecular weight is 4.02, and its electron configuration is 1s2.
Balloons are colorful, fun stretchy bags that can hold gases like helium or air inside without letting them escape. Modern balloons are made from many colors (balloons come in 53 different colors and shades) and materials like latex, rubber or a nylon fabric. Balloons were not always used to make kids happy. The early balloons were made of the bladders of animals, after being dried, like a pig’s bladder. They were created by a scientist name Michael Faraday for his gas experiments in 1824. Faraday’s “balloons” were made from elastic bags and he filled with gases for experimental study. He made his balloons by taking two round sheets of rubber and sealing the edges together. Because he didn’t want to have the balloon stick together in the center, he put flour on the inside to keep the center area from sticking. Balloons are made from a very long process in a factory. First, dye is poured into a tank of latex. The dye is filtered through cheesecloth to remove lumps of dye. Then, agitators mix the dye for 15-16 hours. This distributes the color and keeps the latex moving so it doesn’t harden. Balloon forums are sprayed by nozzles with hot water to clean the balloon forums as they go down the conveyor belt. A machine flips and dips the forums into a liquid that carries an electric charge that will attract the colored latex. Brushes roll up the ends of the balloons for the lips. Balloons are then mixed with other liquids that help them expand and be blown up and are then ready.
A previous experiment tested how strong helium was against air. The hypothesis was that helium would lift up the balloons better than air. In the first experiment, more and more helium was put in with less and less air in the same balloons to see which would float the longest. In the second experiment, helium balloons were put in front of a fan at different intensities and measured after let go to see how far they floated. In the third experiment, different numbers of dominoes were tied to the end of the string on the balloons to see how long it would take to fall. In the fourth experiment, multiple balloons were tied to a wooden toy car to see if it would decrease the weight of the car. In the fifth experiment, different amounts of helium were put into the balloons to see how long they would float. In the sixth and final experiment, the toy car from experiment four were set out for different amounts of time to see if the weight increased because the balloons would lose helium. The conclusion was that helium is better at lift than air and should be used instead of air.

MATERIALS AND METHODS

In the four experiments, a helium tank, 2 meter sticks, an incubator, a freezer, a timer, 12 balloons and string, water, a high and low ceiling, and optional helpers were used.

For each experiment, three data points were averaged and used in the analysis. The first experiment was to see if cooling a helium balloon would affect its flight performance. A balloon was filled with helium. Then it was put in the freezer for different amounts of time. The balloon was removed from the freezer and held against the ground and released at the same time as the start of a stopwatch. When the balloon hit the ceiling, the stopwatch was stopped. After the balloon was allowed to warm back to room temperature, it was placed back in the freezer for a longer amount of time and the cycle was repeated.

The second experiment examined if heating a helium balloon would affect its flight performance. A different helium balloon was placed in the incubator for different amounts of time. The balloon was removed from the incubator and held against the ground. It was released at the same time as the start of a stopwatch. When the balloon hit the ceiling, the stopwatch was stopped. When the balloon returned to about room temperature, the cycle was repeated using longer and longer exposures to heat.
The third experiment examined whether the age of the balloon would affect its flight performance. A third helium balloon was attached to a very long string. Then, the balloon was left alone for different amounts of time. After, the balloon was held against the ground and released in the staircase to the second floor of the CA Middle School Building (or any high ceiling) at the same time as the start of a stopwatch. When the balloon hit the ceiling, the stopwatch was stopped. The balloon was left to age for several longer time periods, and then the experiment was repeated. The two meter sticks were used if the balloon got stuck on the ceiling.

The fourth experiment examined how water placed inside of helium balloons would affect flight performance. Twelve (12) balloons were filled with various amounts of water and then filled with helium. The volume of helium used in each experiment stayed the same. The water volume varied up to a maximum of 10 mL. Then, each balloon was held against the ground and released to a low ceiling at the same time as the start of a stopwatch. When a balloon hit the ceiling, the timer was stopped. Then the balloon was thrown away and the next balloon was tested.

RESULTS AND DISCUSSION

![Graph showing the relationship between time in the freezer and time it took for the balloon to hit the ceiling.](image)

**Figure 3.** How the time of the balloon in the freezer affects its flight performance.
The shortest time in the freezer took the shortest time to hit the ceiling. The longest time in the freezer took the longest time to hit the ceiling. So, the longer the balloon was left in the freezer (or the colder the balloon was), the longer it took to hit the ceiling. The balloon took longer to hit the ceiling when it was colder because the helium inside of the balloon was colder which makes the helium rise at a slower pace.

![Graph](image)

**Figure 4.** How the time of the balloon in the incubator affects its flight performance.

The shortest amount of time in the incubator took the longest to hit the ceiling. The longest time in the incubator took the shortest time to hit the ceiling. So, the longer the balloon was left in the incubator, the shorter time it took to hit the ceiling. The balloon took a shorter time to hit the ceiling when it was warmer because the helium inside of the balloon was warmer which makes the helium rise faster.
Figure 5. How the age of the balloon affects its flight performance.

This experiment proved that the age of the balloon (in minutes up to about 30 min) does not affect its flight performance as much as expected. The flight performance stayed close to the same over the course of the experiment.

Figure 6. How the amount of water inside of the balloon affects its flight performance.
The amount of water in the balloon (in mL up to 7 mL) does not affect the flight performance much at all. The flight performance only slightly changes the flight performance as the water amount increases.

CONCLUSION

A balloon was put in the incubator for different amounts of time and timed to see how long it would take for them to hit the ceiling. This was expected because the hypothesis was that the hotter the balloon was, the faster it would fly. The results of these experiments prove that adding more heat to an air balloon will make it fly faster. A future experiment that could be done is putting a balloon under an infrared light to see if the balloon flies faster because of the heated gas.

CITATIONS


