Journal of Physics Special Topics

An undergraduate physics journal

A4_7 Would The Odyssey Fly?

B. Henderson, A. Hogan, N. Jinnah, J. Terry

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

December 13, 2018

Abstract

The feasibility of the Odyssey being used as a hot air balloon is assessed. The buoyancy force required to lift the Odyssey off the ground is calculated to be 7.051 $\times 10^6$ N , meaning the density of the heated air inside the balloon would need to be -14.97 kgm^{-3}. This means the Odyssey would not be able to fly, if it were acting as a hot air balloon.

Introduction

In Nintendo's Super Mario Odyssey, Bowser has kidnapped Princess Peach with the intent of marrying her. In an attempt to rescue her, Mario follows Bowser's ship from kingdom to kingdom in a top hat shaped aircraft called 'The Odyssey' which is powered by propellers. At each kingdom, the Odyssey requires a certain number of 'power moons' in order to reach the next kingdom; With every power moon the Odyssey's sail gets closer to being completed. At this point, the Odyssey now looks like a hot air balloon. This raises the question, if the Odyssey was a hot air balloon, and not propelled by the propellers, would it be able to fly?

In order to complete the calculations, the balloon on the Odyssey is assumed to be completely spherical and of negligible mass, and the ship is assumed to have a negligible buoyancy force, compared to other values calculated in this paper. It is assumed that the Odyssey is made out of Aluminium, like most aircrafts are. The Odyssey's ship is modelled as two cylinders on top of each other, with the top cylinder assumed to be hollow, to simplify the top hat shape.

Analysis

Figure 1: An image showing Mario standing next to the ship of the Odyssey.

Figure 2: An image showing the full Odyssey with ship and baloon.

In Super Mario Odyssey, Mario appears to be two thirds of the height of a man in New

Donk City, which is modelled after New York City. Therefore the height of Mario was calculated using the average height of an American man, 175.7 cm. Therefore Mario has an estimated height of 117.1 cm. Using Figures 1 and 2, the dimensions of the Odyssey are estimated by comparing Mario's height to the Odyssey. It is estimated that the height of the ship is 7.5 times the height of Mario, 878.5 cm. The balloon is also estimated to be 5 times the height of the ship. This provides a balloon radius of 2.5 times the height of the ship, 2196.3 cm. Using the same scaling method, the following model was created to show the dimensions of the ship:

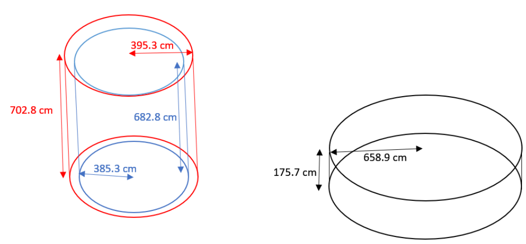

Figure 3: The model of the the Odyssey as 2 cylinders. Left- Top Cylinder showing the outer cylinder (red) with the inner cylinder (blue). Right- The base cylinder for the ship (black). All models show the height and radii

The volume of a cylinder is:

$$V = \pi h r^2 \tag{1}$$

Where V is the volume, h is the height of the cylinder and r is the radius of the cylinder. Using Equation 1 and the values for the height and radius, the volumes of the bottom cylinder (black), inner top cylinder (blue) and the outer top cylinder (red) can be calculated. This produces volumes of 2.396 $\times 10^8$ cm^3, 3.450 $\times 10^8$ cm^3 and 3.185 $\times 10^8$ cm^3 for the bottom, outer and inner cylinders respectively. The total volume for the top cylinder is equal to the outer cylinder volume (red) minus the inner cylinder volume (blue). This provides a total volume for the top cylinder of 2.656 $\times 10^7$ cm^3. The volume of the balloon can also be calculated by using the equation for the volume of a sphere,

$$V_{balloon} = \frac{4}{3}\pi r^3 \tag{2}$$

This provides a volume of 4.437 $\times 10^4$ m^3. The mass of of the ship must also be calculated. This is equal to the total volume of aluminium needed to create the ship, multiplied by the density of aluminium, 2.7 g cm^{-3} [1], producing a mass of 7.187 $\times 10^5$ kg.

In order to lift the ship off the ground, the buoyancy force, F_B must be greater than the gravitational force acting on the ship. The gravitational force is calculated by multiplying the mass of the ship by the acceleration due to gravity, $g = 9.81$ ms^{-2}, and a value of 7.051 $\times 10^6$ N is obtained. Therefore the minimum buoyancy force is equal to the gravitational force and the equation below:

$$F_{B,min} = g(\rho_{air} - \rho_{balloon})V_{balloon} \tag{3}$$

Where ρ_{air} and $\rho_{balloon}$ are the densities of air outside and the heated air inside the balloon respectively. Once rearranged, the density of the heated air inside the balloon is calculated and found to be -14.97 kgm^{-3}.

Conclusion

Therefore, the dimensions of the Odyssey, from the Super Mario Odyssey game, mean the ship would not be able to fly. In comparison, the largest passenger hot air balloon is 40 m high [2], similar to the diameter of the Odyssey's balloon. This carried a total 32 passengers [2], which would be a much smaller mass than the mass of the ship

References

[1] `https://www.thyssenkrupp-materials.co.uk/density-of-aluminium.html` [Accessed 19th November 2018]

[2] `http://www.cameronballoons.co.uk/news/the-worlds-largest-passenger-ride-balloon` [Accessed 19th November 2018]