Appendix

D

Technical Writing Samples

Elements of a Formal Technical Report

Examples

The selected examples shown here are technical writing samples that are based on Laboratory Exercise 2.

Example Abstract

The present work seeks to investigate the buoyancy phenomenon as described by Archimedes Principle. Experimental results were obtained for the net lifting force of several helium-filled balloons, ranging in diameters of 18-37 inches. Comparisons were made with theoretical calculations based on Archimedes Principle. The results validated the linear relationship between the lift and the volume of the envelope over the range of 0.12-0.97 lbs net lift. Comparisons between the theoretical and the experimental values were within approximately 6 percent at most. Therefore, theoretical results can be used to accurately predict the net lift of lighter-than-air vehicles.

Example Introduction Section

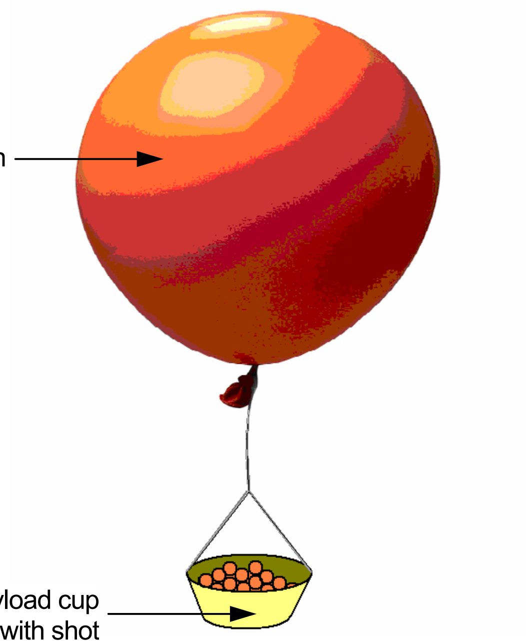
To be written.

Example Experimental Setup and Procedure Section

The experimental determination of buoyancy involved helium balloons and a weight balance procedure. The equipment, instrumentation, and experimental method are summarized in this section.

Equipment

The balloons used were made of latex and capable of inflated diameters of up to 36-40″. The latex envelopes weighed approximately 0.1 lb each. Each balloon was attached to a cup that could be loaded with a balancing payload weight. The payload weight typically consisted of a quantity of copper shot (i.e., airgun BB's). This setup is depicted in Figure 31.



• Figure 31. Experimental apparatus for measuring buoyancy

Instrumentation

The primary instrumentation involved length and weight measurement. The circumference of each balloon was measured with a 120″ tailor's tape measure. The weight of each balloon component was obtained using an analytic pan balance (maximum capacity = 0.7 lb).

[This would be a sufficient treatment of the instrumentation used in this particular experiment. Normally, the Experimental Setup section might include a diagram and/or additional specifications of the instruments used.][16]

Experimental Method

To obtain theoretical and experimental measurements of buoyancy, each balloon was first inflated with helium to an actual inflated diameter of 20-37″. After the balloons were tied off, the mean circumference was determined using a number of different cutting planes through each inflated balloon, to account for the non-spherical shape.

Then the payload cup was attached and loaded with shot until buoyancy equilibrium was achieved. Occasionally, small bits of paper were added to trim out the total vehicle. After the equilibrium was achieved, the envelope and payload were weighed. When the payload weight exceeded the capacity of the balance, it was subdivided into quantities of less than 0.7 lbs.

Example Results Section

The results are presented for the determination of lifting capacity for 9 aerostatic vehicles. The procedure of Section 3 *[this would be the Experimental Setup section]* was followed to fill the balloons with helium and secure the envelopes. From an average circumference for each balloon, the volume was determined. This volume, which was in the range 3–14 ft^3, was then used to calculate the theoretical lifting capacity based on equation 5 of Section 2 *[this would be in the Theory section]*. The density of the helium was calculated by assuming that the pressure and temperature inside the envelope were at ambient conditions (1013mb and 20°C, respectively). Experimental determination of the lifting capacity was made by balancing out the

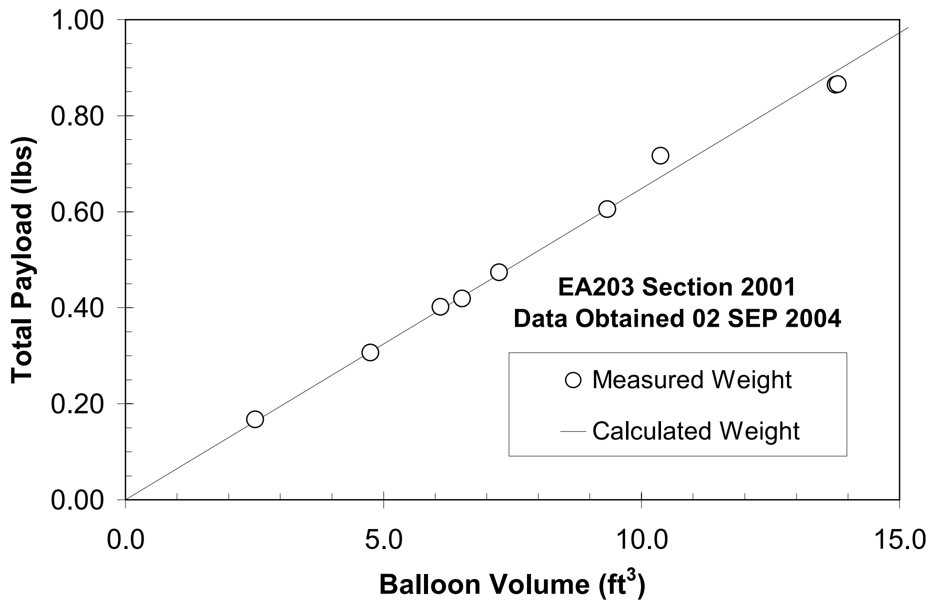
[16] These parenthetical comments are for reference only and should not be included in a technical report. It is common and acceptable practice to refer to previous sections of a report.

buoyant force with weights. These total measured payloads varied from 0.2–0.9 lbs. A summary of these calculations and measurements is shown in Table 15.

• Table 15. Calculated weights of aerostatic vehicles

Balloon Volume, ft³	Measured Weight (Total Payload), lbs	Theoretical Weight (Lift), lbs	% Error
2.51	0.167	0.163	2.5
4.75	0.306	0.308	0.5
6.11	0.402	0.396	1.5
6.52	0.419	0.423	0.9
7.24	0.474	0.470	0.8
9.34	0.606	0.606	0.0
10.37	0.716	0.672	6.5
13.77	0.864	0.893	3.2
13.80	0.866	0.895	3.3

The lifting capacity results are graphically presented in Figure 31. This figure shows the total payload of the aerostatic vehicle plotted against the enclosed volume of each balloon. Both theoretical and experimental results are presented. It is clear from the plot that the predictions for lifting capacity should follow a linear relationship. The slope of this line is proportional to the differential in density between the enclosed helium and the displaced air (equation 5). The experimental data points closely follow the linear relationship, with a maximum error of 6.5%. The average error for all nine balloons is far below this at 0.4%. With such good agreement between theory and experiment, it is clear that lifting capacities of helium aerostatic vehicles can be accurately predicted using these methods.



• Figure 32. Lifting capacity of aerostatic vehicles

Sources for error[17]

In the present experiment, there were a few sources for experimental error. First, the oblateness of the inflated balloons challenged the assumption that the envelope volume was spherical. This assumption was used to calculate the volume from the average circumference. The actual circumference measurements were relatively accurate, estimated to be within ±¼″. Second, obtaining the maximum weight lifted depended on having a leak-proof envelope and achieving equilibrium. The balloon tested by the author showed no signs of leakage. However, equilibrium was difficult to achieve, as slight air currents in the room cause the balloon to drift up or down, even at the same loading condition. The weight measurements were displayed with four digits of accuracy, but the recorded values are precise to within ±0.0002 lb.

Example Conclusions Section

The present work shows that Archimedes Principle has been accurately applied to calculating the net lifting force of helium-filled balloons. The theoretical trend, a linear relationship between buoyant force and the volume of the envelope, was precisely modeled in the experimental data, with an average error of 0.4%.

In summary, the following conclusions can be drawn from this experiment:

- The linear relationship between the lift and the volume was validated.
- The results apply to the range of balloons tested, volumes of 3–14 ft^3 and total weights of 0.2–0.9 lbs.
- Maximum experimental error was 6.5%.
- These conclusions demonstrate that the theoretical results obtained from Archimedes Principle can be used to accurately predict the net lift of lighter-than-air vehicles. The predictions can be applied to the preliminary sizing of aerostatic vehicles, blimps, airships, or hybrid air vehicles.

[17] **NOTE:** If you list "human error" as a source of experimental error (a common misconception for pre-engineering students), then you didn't do the experiment carefully enough, and it should be re-done! You can <u>always</u> estimate the precision to which you obtained your measurements.