UCLA LEMUR Lab Experiment report
Experiment title: Testing customized balloon shape
Experiment date: xxx
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Experiment Report: Testing customized balloon shape

Jiahao, Zhaoliang

1 Objective and Purpose

1. What is the objective of the experiment

   - To explore the relationship between 2d shape and 3d inflated balloon shape
   - Test the relationship between the volume and the surface area of balloons made of different 2d shapes

2 Hypothesis / Questions that you try to answer

1. what is your hypothesis?

   - Assume that the inflated balloon always tends to be round.
   - Assuming that the volume of a balloon with a specific shape can be equivalent to a sphere with the corresponding surface area.
   - Assuming we want to use an envelope of any size as the cover for an inflatable balloon. The total area size of the envelop of that balloon is S, calculate the diameter of equivalent sphere using Sphere surface area calculation formula: $S = 4\pi r^2 = \pi D^2 \rightarrow D = \sqrt{S/\pi}$, now calculate the approximate volume of this shape using formula of sphere volume: $V = 4/3\ pi(D/2)^3$

2. What is the independent variable? How do you measure it?

   - The size of different 2d shapes, and this will be designed by CAD or graphics Software
   - The volume of gas filled into the balloon, and this will be calculated based on the weight of the object being lifted.

3. What variables did you control?

   - The size of different 2d shapes.
   - The weight of the object before and after the balloon lifts.

3 Materials

1. What materials and equipment do you need to finish this experiment?
    - Mylar
    - Helium tank
    - Searing-iron: to seal the boundary
    - Glue gun: to seal the boundary, not sure which one is better
    - String: 1. To seal the air inlet, 2. Connect the balloon to the object.
    - Sensitive electronic scale
    - The object being lifted by balloon
    - Scissor: to cut mylar
    - Paper of fixed shape: To make a 2D mold, and it needs to be thicker
    - Maker pen: Follow the model and draw on mylar paper
    - Laser cutter: to cut the paper into a specific shape
    - Big table: to place the mylar and easy to manufacture
    - Temperature and humidity sensor
2. What materials do we need to purchase online? what is the order link?
    - Mylar
    - Helium tank
    - Searing-iron
    - Sensitive electronic scale: do we have this in the lab?
    - Sticker paper: do we have this in the lab?

4 Procedures

Tell exactly how to set-up and maintain your experiment. Be sure to include such things like: the number that we tested, the settings for each small experiment sections.

4.1 Experiment1: Manufacturing a balloon

Tutorial: There are lots of DIY videos online:

- Most recommended: https://www.youtube.com/watch?v=aO7twPXnclk
- Second recommended: https://www.youtube.com/watch?v=c8ofefkuNog
- https://www.youtube.com/watch?v=ejtFL5bLlkc
- https://www.youtube.com/watch?v=56KqPMobyJw

Procedures: The basic steps of making a customized mylar balloon:

- Use CAD software to make a corresponding 2d shape.
- Use lazer cutter to cut a sticker paper and make a mold.
- Place the mold on the mylar paper and draw a specific shape using marker pen or crease the mylar in that mold shape.
- Use searing-iron to seal the boundary.
- Inflate the balloon.

4.2 Experiment2: To explore the relationship between 2d shape and 3d inflated balloon shape

Objective The objective of this experiment is to find out the relationship between 2d shape and specific 3d inflated balloon shape.

- To be more specific, we start from the following 3 different shapes (see Fig. 1, from left to right: sphere, wheel, spindle) and verify our assumption from that.
- Assume that for sphere, we need 4 pieces to make one.
- Assume that for wheel shape, we need 2 pieces to make one.
- Assume that for spindle, we need 2 pieces to make one.

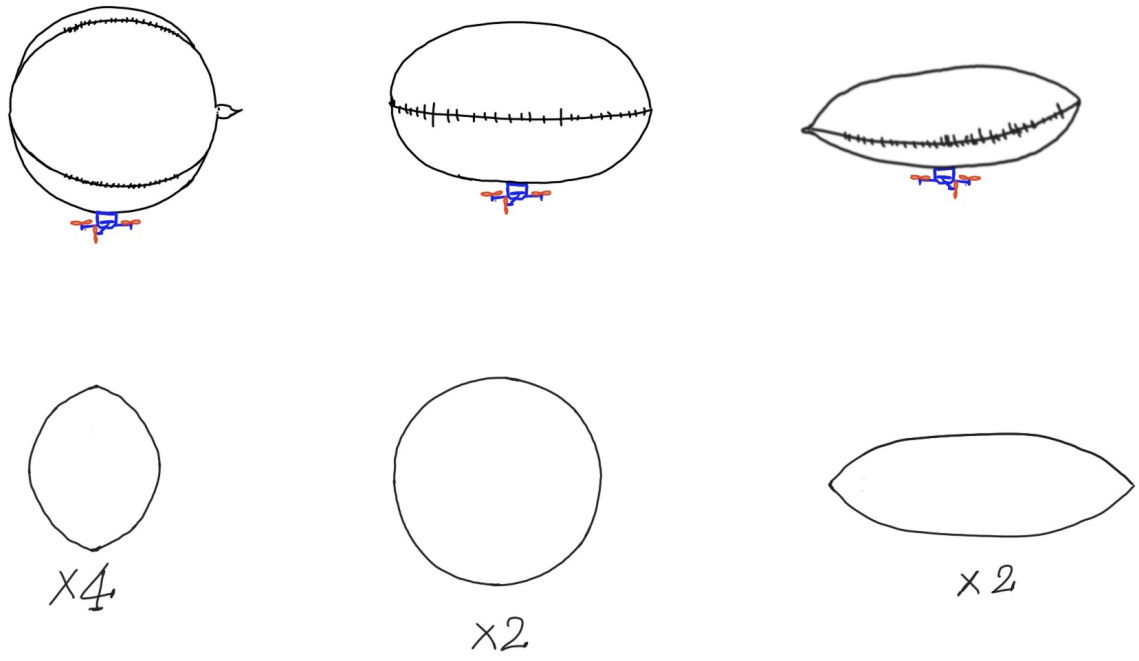

Figure 1: 3d shapes vs. 2d shape

Procedures:

- We need to generate different 2d shapes while we manufacturing balloon.
- Starting from the small size before we scale up our balloon size. In this step, we mainly need to find out the relationship.
- When we master the relationship between 2d and 3d, we can make a bigger one.

4.3 Experiment3: Test the relationship between the volume and the surface area of balloons made of different 2d shapes

Objective: The objective of this experiment is to:

- Find out an efficient way of measure the volume of customized balloon.
- Find out the relationship between total surface area and the volume of 3d balloon.
- Verify our theory in the hypothesis part.

Procedures: There are three tasks corresponding to three goals/objectives.

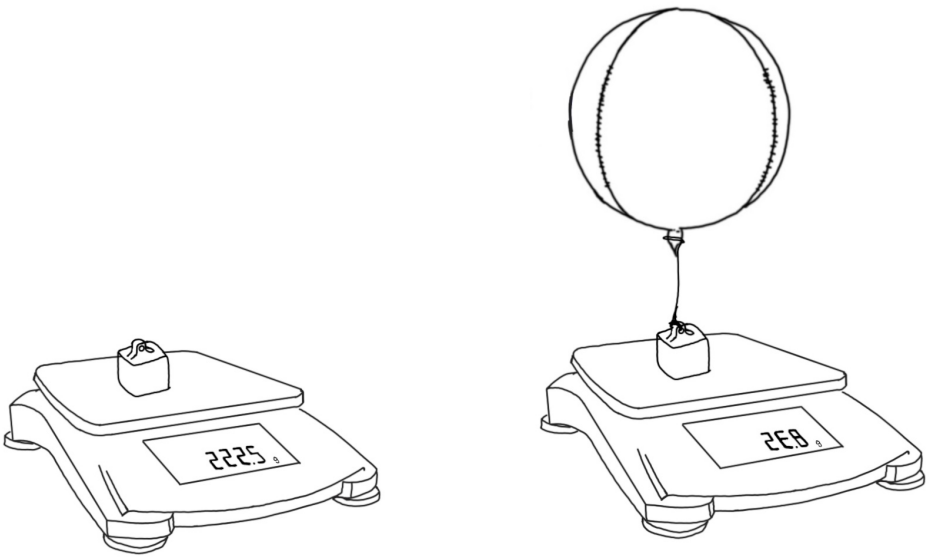

Figure 2: A schematic of measuring the volume of a balloon

1. Measure the volume of customized balloon.
   - The experiment can be seen from the Fig. 2
   - We need to measure the difference W_{diff} between before and after the object lifted by our balloon. Here we use Sensitive electronic scale to do that.
   - After that, we will know the total buoyancy of our balloon: $B_{total} \simeq W_{diff}$.
   - The use formula: $B_{total} = (\rho_{air} - \rho_{helium}) \times V \rightarrow V = \frac{W_{diff}}{(\rho_{air} - \rho_{helium})}$

- In order to determine the density of the air and helium, we also need to know the temperature of the surroundings. We will use temperature and humidity sensor to detect the temperature and query the corresponding density at that temperature.

2. Find out the relationship between total surface area and the volume of 3d balloon:
   - Calculate the total surface area on our software
   - Measure the volume of corresponding balloon.
   - We may need at least 10 sample in order to draw the relationship figure
   - The x axis is the total surface area, and the y axis is the volume of customized balloon.
3. Verify our theory in the hypothesis part:
   - Fit the data obtained from the previous experiment.
   - Use our theory to draw a plot which x axis is the total surface area, and the y axis is the volume of customized balloon.
   - Compare experimental and theoretical data curves and calculate errors.