Date of Lab 11/8/17 Date of Submission 11/15/17

Laboratory Report

Title Buoyancy

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Summary

In this experiment, we hung a string with weights and attached to a spring scale in order to calculate the observed value. We investigated the observed value of buoyant force by looking at the difference of elastic force in air and elastic force in water. Also, we investigated the theoretical vale by using Archimedes' Principle.
In the Cartesian driver experiment, we investigated the relationshiop between the upward buyant force and the downward gravity.

・Meet a deadline ・Write logically ・Write clearly ・Write with your own words

Teacher's Comments

Clear discussion with a beautiful table.

1	2	3	4	5	6	7	8	9
Due	Summary	Intro.	Method.	Results	Table/Fig.	Discussion	Clearness	General
+				+	+	+	++	++

* Use this form as a cover sheet.
* Submit your reports by the seventh day after your lab.

11-I Haruka Kushima

Introduction

Objective:
Measuring buoyant force on a body in water.

Theory and Past knowledge:
An object completely immersed in a fluid experiences an upward buoyant force equal to the weight of fluid displaced by the object. (Archimedes' Principle)

Theoretical method: $\mathbf{F=\rho_w Vg}$

F= magnitude of buoyancy V=volume of an object
ρ=density of water g=gravitational acceleration

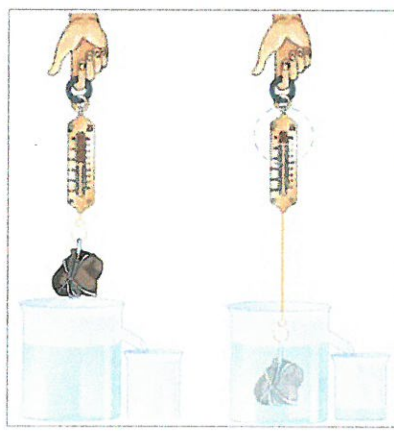
Observed method: $\mathbf{F=F_1- F_2}$

F_1=the elastic force in air F_2=the elastic force in water

Experiments

Materials

- Overflow can
- Aluminum foil cup
- String
- Spring measure
- Water
- Weight
- PET bottle
- Glass test tube



Procedures
Experiment 1

1. Measuring the mass of an aluminum foil cup with a scale
2. Put water into an overflow cup (Eureka can) to overflow
3. The above aluminum foil cup is placed under the mouth of the overflow cup.
   A weight is hang with string and sank completely in the water in the overflow cup.
   Overflowed water is collected in the aluminum foil cup.
4. Measuring the mass of the aluminum foil cup/water with a scale
5. Measuring the mass (**m**) of the weight with a scale
6. Calculation of the volume of the weight
   Density of water: ρ_w=1.000 g/cm^3 = 1000 kg/m^3

7. Calculation of the theoretical value ($\rho_w Vg$) of the buoyant force exerted on the weight in water
8. Calculation of the density of the weight
9. Zero adjustment of a spring scale
10. Put water into an overflow cup (Eureka can)
11. The weight is hang with string, and the mass is measured with the spring scale (The weight is in air)
12. The weight is hang with string, and the elastic force exerted on the weight is measured with the spring scale (The weight is in air)
13. The weight is hang with string, sank completely in water in the overflow cup, and the elastic force exerted on the weight is measured with the string scale (The weight is in water)
14. Calculation of the observed value ($\rho_w Vg$) of the buoyant force exerted on the weight in water

Experiment 2- Cartesian Driver

1. Measuring the mass of a test tube with a scale (**m**)
2. Calculation of the volume of solid glass of the tube (V_g) using the mass and the density of glass $\rho_g = 2500\ kg/m^3$
3. Put water in a pet bottle up to the neck. Put water in the test tube to the about half height. Insert the test tube by upside-down into the pet bottle. At this moment the test tube must be placed upward. If not, take the test tube out and try again.
4. Close a bottle stopper tightly. Push the body of the bottle tightly and observe how the test tube goes down. Read the volume of air inside the test tube (V_a) when it is in the intermediate position of the bottle.
5. Discuss about the equilibrium between the buoyant force and gravity
   Buoyancy: by the volume of the solid glass + the volume of air
   $F_b = (V_g + V_a)\rho_w g$
   Gravity: the mass of the test tube
   $W = mg$

Results

Experiment 1

Volume of the Wight **V**	cm^3 m^3	36.1 cm^3 $36.1 \times 10^{-6}\ m^3$
Mass of the Weight **m**	g kg	103.9 g 0.1039 kg
Buoyant force (Theoretical) $\rho_w Vg$	N	0.354 N
Density of the Weight $\rho_m = m/V$	g/cm^3 kg/m^3	2.878 g/cm^3 2878 kg/m^3

3 digits.

Mass of the Weight m	g kg	105 g 0.105 kg
Elastic force **F1** (The weight is in air)	N	1 N
Elastic force **F2** (The weight is in water)	N	0.65 N
Buoyant force (observed) F_b=F1-F2	N	0.35N

Experiment 2-Cartesian Driver

Mass of a test tube m	g kg	14.5 g $14.5x10^{-3}$ kg
Volume of solid glass of the tube V_g	cm^3 m^3	5.8 cm^3 $5.8x10^{-6}$ m^3
Volume of air inside the test tube (V_a)	cm^3 m^3	8 cm^3 $8.0x10^{-6}$ m^3
Gravity exerted in the test tube (vertically downward) W=mg	N	0.142 N
Buoyancy by the sum of the volume of the solid glass and the volume of air (vertically upward) $F_b=(V_g+V_a)\rho_w g$	N	0.135 N

Discussion

In experiment 1, we used the theoretical value and observed value to calculate the percentage error.

Theoretical value: 0.354 N
Observed value: 0.350 N

l0.354-0.350l/0.354 x 100%= 1.13 %

✓

The error was 1.13%. The error was very low, therefore **F=ρVg** is proved. Even though we concluded that **F=ρVg** is proved, there was an error because...

- we didn't read the scale of the spring correctly
- when we calculate, we round off

Also in the Cartesian driver experiment, we compared the gravity acting vertically downward and the buoyancy acting vertically upward to calculate the percentage error.

Buoyancy: 0.135 N
Gravity: 0.142 N

l0.142-0.135l/0.135 x 100%= 5.2 %

The error was 5.2%. The error was ~~very low~~ significantly small and both of the values were very close. Therefore, we proved that the test tube inside the water was at rest and the buoyancy and the gravity were in equilibrium.

Conclusion

From these two experiments, we conclude that an object completely immersed in a fluid experiences an upward buoyant force equal in magnitude to the weight of fluid dispersed by the object. The magnitude of buoyancy changes with the change in the volume. Archimedes' Principle is proved.

Opinion

In this experiment, there was a lot of time where I had to convert the numbers in different units. Such as from cm^3 to m^3 and g to kg. If I converted the numbers wrong, all of the results in the experiment would change. I had to be very careful. Also, by calculating the percentage error, I was able to know the accuracy of the experiment I did. I noticed that I needed to be more accurate in measuring the scale and rounding off. I look forward to get used on these techniques for more improved and accurate experiment.

Reference

Aki Yamasawa's Lab Report
Kana Kato's Lab Report