Vectors

By

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I. Introduction

Have you ever wondered how a bucket of flowers is suspended from the ceiling, or better yet how much force (weight) does it push down? Newton was the first to discover the actual idea of force. Such a force in the case of the plant is governed by the force of gravity, which Newton then used to calculate the moon's orbit around the earth. In this experiment students will be asked to calculate the force and the mass of a hanging object.

Figure 1 (side view)

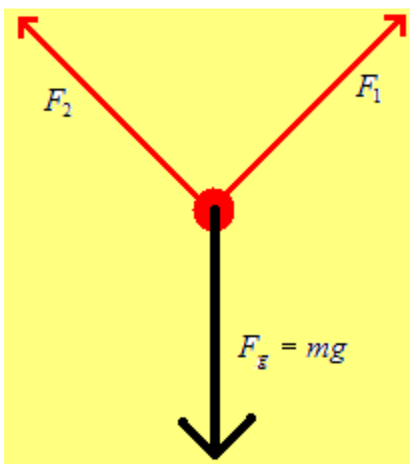

Figure 2

II. Background

A vector is commonly represented by a directed line segment whose length represents the magnitude and whose orientation in space represents a direction. In brief, a vector is a directional quantity that acts at one point. Therefore, adding vectors to one another, considering both magnitude and direction at the same time is difficult.

A vector summation is tricky; however, it has allowed us to discover much of physics in today's time. For example, a force is a vector because it has a direction and a magnitude. Now imagine if there are two forces acting on an object, how would you get the total resultant force? The answer is by vector addition. This is a general formula $\vec{v}+\vec{w}=\vec{R}$ but there is more than that; it breaks up into two components, x-axis and y-axis, so $\begin{matrix} v_x = \vec{v}\cos(\theta) \\ v_y = \vec{v}\sin(\theta) \end{matrix}$ and $\begin{matrix} w_x = \vec{w}\cos(\alpha) \\ w_y = \vec{w}\sin(\alpha) \end{matrix}$. Then you add them piece by piece, the x and y components together:

=> $$\left.\begin{matrix} R_x = v_x + w_x \\ R_y = v_y + w_y \end{matrix}\right\rangle \Rightarrow \vec{R} = \sqrt{{R_x}^2 + {R_y}^2}\ .$$

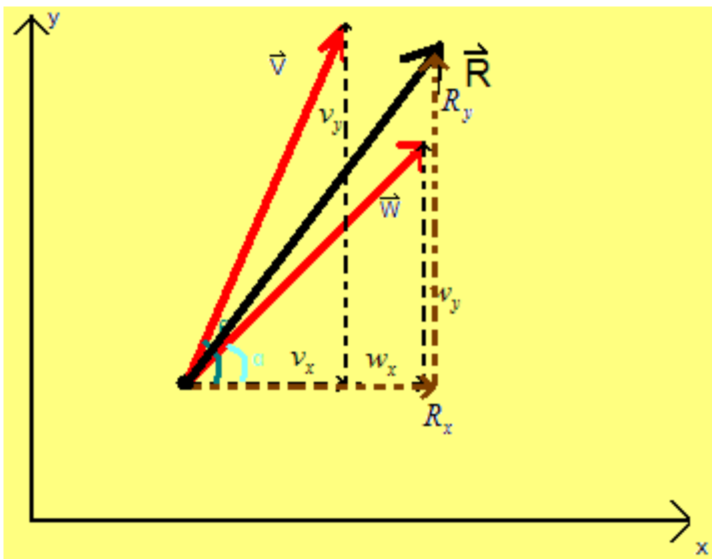

Figure 3

III. Objective:

- Determine the force that is pulling down by the weight
- Determine the mass of the object

IV. Equipment List

-PC
-LabPro or Universal Lab Interface
-Logger *Pro*
-Two Force Sensors
-A string
-A protractor
-Two Stands
-Table
-Free weights

V. Experimental Procedure:

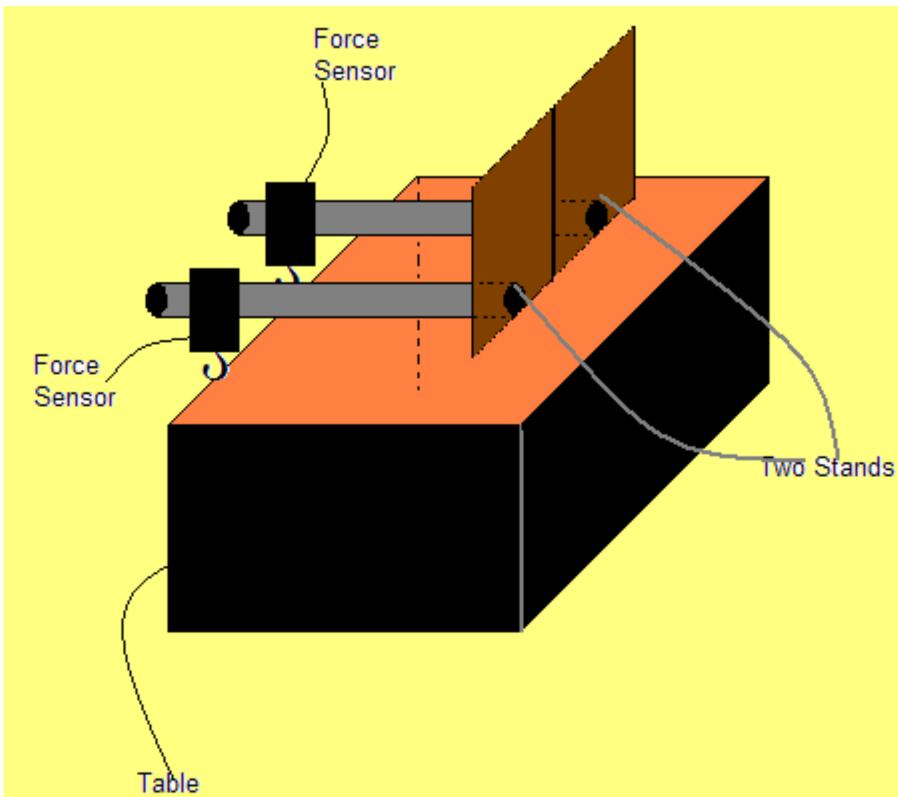

Figure 4

1) Set up the two stands and the two force sensors as shown in figure 4. Make sure that the two stands are fixed firmly.

2) Connect a string to both of the force sensors.

3) Connect the two Dual-Range Force Sensors to Channels 1 and 2 on the LabPro or Universal Lab Interface. If you are using Force Probes, connect them to PORT 1 and PORT 2.

4) Since you will be comparing the readings of two different Force Sensors, it is important that they both read force accurately. In other words, you need to *calibrate* them. To calibrate the first sensor,

a. Choose Calibrate from the Experiment menu. Click on the port of the first Force Sensor so the port is highlighted, and if necessary, on the port of the second Force Sensor so it is *not* highlighted. Click on the [Perform Now] button.
b. Remove all force from the first sensor and hold it vertically with the hook pointed down. Enter a **0** (zero) in the Value 1 field, and after the reading shown for Input 1 is stable, click [Keep]. This defines the zero force condition.
c. Hang the 500-g mass from the sensor. This applies a force of 4.9 N. Enter **4.9** in the Value 2 field, and after the reading shown for Input 1 is stable, then click [Keep].
d. Click [OK] to complete the calibration of the first Force Sensor.

5) Repeat the process for the second Force Sensor.

6) Now you can perform a trial measurement. Click [Collect] to begin. Put the free weights starting from 100g to 500g; collect the data with every weight and save it.

VI. Analysis/Questions

1) Using what you know about the force from the force sensors, determine the mass of every free weight (Note: it should match the original weights 100g to 500g).

2) Take an unknown weight and follow the same procedure from 1 to 3 and calculate the mass of the unknown weight. Does it match? Ask your instructor to tell you the mass of the weight after you are done.

3) If there is a difference between the sensor values and the calculated values, what do you think caused such a difference?

References

[3] K. Appel, J. Gastineau, C. Bakken, D. Vernier, Physics with Computers. Vernier Software & Technology, Beaverton, Oregon, 3rd Ed., (2003).