

# Force Table Experiment

---



## I. INTRODUCTION

### 1.1. Vector and Scalar Quantities

Some physical quantities are scalar quantities whereas others are vector quantities. When you want to know the temperature outside so that you will know how to dress, the only information you need is a number and the unit “degrees C” or “degrees F.” Temperature is therefore an example of a **scalar quantity**, which is defined as a quantity that is completely specified by a number and appropriate units. That is,

A scalar quantity is specified by a single value with an appropriate unit and has no direction.

Other examples of scalar quantities are volume, mass, and time intervals. The rules of ordinary arithmetic are used to manipulate scalar quantities.

If you are getting ready to pilot a small plane and need to know the wind velocity, you must know both the speed of the wind and its direction. Because direction is part of the information it gives, velocity is a **vector quantity**, which is defined as a physical quantity that is completely specified by a number and appropriate units plus a direction. That is,

A vector quantity has both magnitude and direction.

## 1.2. Adding Vectors

The rules for adding vectors are conveniently described by geometric methods. To add vector **B** to vector **A**, first draw vector **A**, with its magnitude represented by a convenient scale, on graph paper and then draw vector **B** to the same scale with its tail starting from the tip of **A**, as shown in Figure 1. The **resultant vector**  $\mathbf{R} = \mathbf{A} + \mathbf{B}$  is the vector drawn from the tail of **A** to the tip of **B**. This procedure is known as the triangle method of addition.

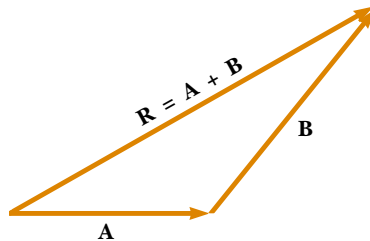


Figure 1. When vector **B** is added to vector **A**, the resultant **R** is the vector that runs from the tail of **A** to the tip of **B**.

Consider a vector **A** lying in the  $xy$  plane. The product of the component  $A_x$  and the unit vector **i** is the vector  $A_x \mathbf{i}$ , which lies on the  $x$  axis and has magnitude  $A_x$ . (The vector  $A_x \mathbf{i}$  is an alternative representation of vector  $\mathbf{A}_x$ .) Likewise,  $A_y \mathbf{j}$  is a vector of magnitude  $A_y$  lying on the  $y$  axis. (Again, vector  $A_y \mathbf{j}$  is an alternative representation of vector  $\mathbf{A}_y$ .) Thus, the unit vector notation for the vector **A** is

$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

Now let us see how to use components to add vectors when the geometric method is not sufficiently accurate. Suppose we wish to add vector **B** to vector **A**, where vector **B** has components  $B_x$  and  $B_y$ . All we do is add the  $x$  and  $y$  components separately. The resultant vector  $\mathbf{R} = \mathbf{A} + \mathbf{B}$  is therefore

$$\begin{aligned} \mathbf{R} &= (A_x \mathbf{i} + A_y \mathbf{j}) + (B_x \mathbf{i} + B_y \mathbf{j}) & R_x &= A_x + B_x \\ \mathbf{R} &= (A_x + B_x) \mathbf{i} + (A_y + B_y) \mathbf{j} & R_y &= A_y + B_y \end{aligned}$$

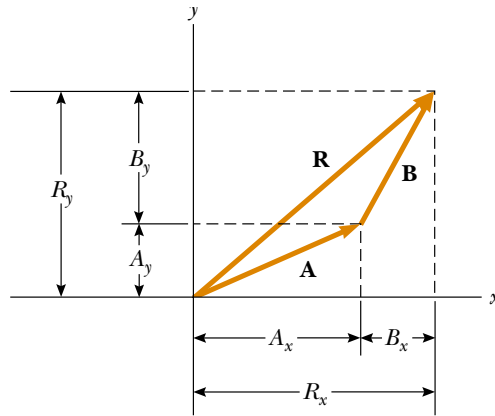


Figure 2. This geometric construction for the sum of two vectors shows the relationship between the components of the resultant **R** and the components of the individual vectors.

We obtain the magnitude of **R** and the angle it makes with the *x* axis from its components, using the relationships

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(A_x + B_x)^2 + (A_y + B_y)^2}$$

$$\tan \theta = \frac{R_y}{R_x} = \frac{A_y + B_y}{A_x + B_x}$$

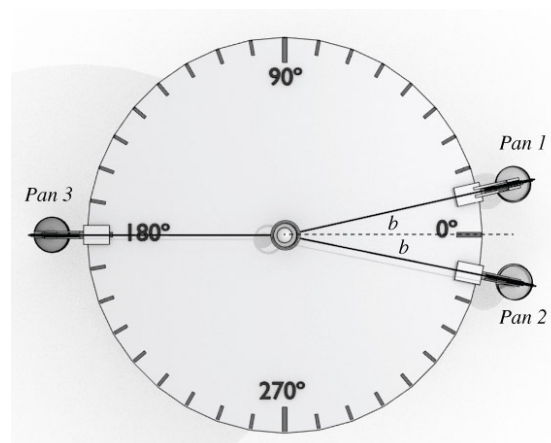
## II. APPARATUS

Force table, rope, various weights

## III. EXPERIMENTAL PROCEDURE

Given two force vectors you will determine the third force that will produce equilibrium in the system. This third force is known as the equilibrant and it will be equal and opposite to the resultant of the two known forces.

The hanging masses will produce a tension force in each string. The masses are directly proportional to the gravitational force (which you will learn about later in the course). The tension force in each string is equal to the gravitational force. For example, doubling the mass doubles the force, etc. When the forces are balanced, the ring will be positioned at the exact center of the table. When the forces are not balanced, the ring will rest against one side of the central post.



- 1) Please mount the system.
- 2) Get various weights and note their values.
- 3) Please try to find the balancing force and then fill the table for the following situations.
  - I. Situation  $\rightarrow$  ( $F_1 = 0.5\text{N}$ ,  $0^\circ$ ,  $F_2 = 1\text{N}$ ,  $0^\circ$ )
  - I. Situation  $\rightarrow$  ( $F_1 = 0.5\text{N}$ ,  $0^\circ$ ,  $F_2 = 1\text{N}$ ,  $60^\circ$ )
  - I. Situation  $\rightarrow$  ( $F_1 = 0.5\text{N}$ ,  $0^\circ$ ,  $F_2 = 1\text{N}$ ,  $180^\circ$ )

Method	Balancing Force	
	Magnitude	Direction
Experimental		
Using Components ( $R_x$ and $R_y$ )		
Graph		

**Ref.**

- 1) Serway, Beichner- Fen ve Muhendislik icin Fizik 2.