EISCO

USER'S MANUAL

FORCE TABLE

PH 0347C-N8

FORCE TABLE

Introduction:
Student Force Table is designed for student labs and classroom demonstration in collage and high school Physics. It is a simple device for verifying experimentally the laws of composition and resolution of forces and for illustrating vector addition and subtraction. The device is easy to set up and use.

Description:
The force table consists of a circular graduated table top to which pulleys can be clamped and from which weights can be suspended. The table top is mounted on a vertical rod held in a heavy tripod support. Levelling screws in the tripod permit perfect leveling of the table top.

Parts Check List:
The following are the contents of the force table
- Circular table top - 1
- Pulleys with clamp - 4
- Slotted weight set - 4
- Metal Ring - 5
- Thread roll - 1
- Leveling screws - 3
- Tripod Base - 1
- Support rod - 1
- Central pin - 1

Assembly:
Force table is packed disassembled for shipment. Prior to operation, assemble the Force Table in the following manner.
- Screw the vertical support rod in the tripod Base.
- Center the table top over the support rod and screw it on the rod.
- Screw the indicating pin in the center of the table top. Place the center ring around the pin.

- Place the pulleys on the edges of the table and space them according to the requirements of the experiment. Clamp the pulleys in place.
- Attach four equal lengths of cord to the centering ring. Pass one cord over each pulley.
- Attach one weight hanger to the free end of each cord. The force table is now ready for use.

Theory:
Measurable quantities may be classified as either scalar quantities or vector quantities. A scalar quantity has magnitude only but a vector has both magnitude and direction. For example, since to specify completely velocity of a body it is necessary to state not only how fast it is traveling but in what direction it is going, velocity is vector quantity. However, the mass of a body is completely specified by a magnitude and mass is a scalar quantity. Since the weight of a body is the force with which it is attracted by the earth, weight is a vector quantity.

A force is a vector quantity characterized by both a magnitude and direction. A vector is conveniently represented by an arrow that point in the direction of the vector and whose length represents the magnitude of the vector according to same scale. The direction of the vector is usually represented by an angle between the vector and a reference line.

If the two forces are entered on an object, the object will be forced off, we can say that the object is not in equilibrium. To make the object in equilibrium a third force may be applied to balance the existing forces. The third force is called the Equilibrant.

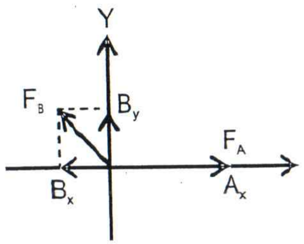
The Equilibrant and the resultant are two different concepts. The resultant of two forces is a force which has an overall effect that is equivalent to the given forces together but it acts in the opposite direction to that of equilibrant.

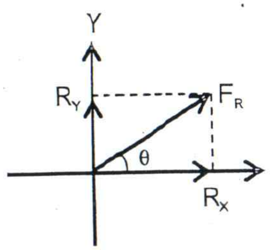
Suppose we have two forces. F_A and F_B acting on an object.

* F_A is in direction of x
* F_B makes an angle of 135° with x.

The resultant of two forces can be found out using two different methods.

1) Graphical Method
2) Component Method





Component Method:
Two forces are added together by adding the x- and y-components of the forces. First the two forces are broken into their x- and y- components using trigonometry:

$$F_A = A_x x + A_y y$$
$$F_B = B_x x + B_y y$$

Where A_x is the x-components of vector F_A and x is the unit vector in the x-direction. See Figure. To determine the sum of F_A AND F_B, the components are added to get the components of the resultant F_R:

$$\mathbf{F_R} = (A_x + B_x)\,x + (A_y + B_y)\,y = R_x x + R_y y$$

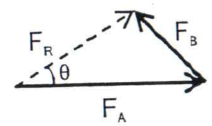
To complete the analysis, the resultant force must be in the form of a magnitude and a direction (angle). So the components of the resultant (R_x and R_Y) must be combined using the pythagoream theorem since the components are at right angles to each other:

$$\mathbf{F_R} = \sqrt{R_x^2 + R_y^2}$$

$$\text{Tan}(\theta) = \frac{R_x}{R_y}$$

And using trigonometry gives the angle:

Graphical Method:
Two forces are added together by drawing them to scale using a ruler and protractor. The second force ($\mathbf{F_B}$) is drawn with its tail to the head of the first force ($\mathbf{F_A}$). The resultant ($\mathbf{F_R}$) is drawn from the tail of $\mathbf{F_A}$ to the head of $\mathbf{F_B}$. See Figure. Then the magnitude of the resultant can be measured directly from the diagram and converted to the proper force using the chosen scale. The angle can also be measured using the protractor.



Adding Vectors Head to Tail

EXPERIMENT : VECTOR ADDITION

Purpose:
The purpose of this experiment is to use the force table to experimentally determine the force which balances two other forces. This result is checked by adding the two forces by using their components and by graphically adding the forces.

Experiment Method:
Two forces are applied on the force table by hanging masses over pulleys positioned at certain angles. Then the angle and mass hung over a third pulley are adjusted until it balances the other two forces. This third force is called the equilibrant (F_E) since it is the force which establishes equilibrium. The equilibrant is not the same as the resultant (F_R). The resultant is the addition of the two forces. While the equilibrant is equal in magnitude to the resultant, it is in the opposite direction because it balances the resultant (see Figure 4). So the equilibrant is the negative of the resultant:

$$(-\mathbf{F_E} = \mathbf{F_R} = \mathbf{F_A} + \mathbf{F_B})$$

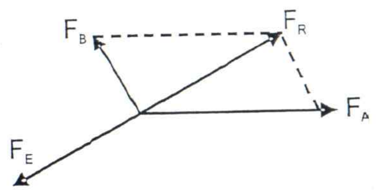


Figure: The Equilibrant Balances the Resultant

To check that equilibrium has actually been attained, pull the ring slightly to one side. Then release the ring. Check to see that the ring returns to the center. If not, adjust the mass or angle of the equilibrant F_E Force.

ANALYSIS:

To determine theoretically what mass should be suspended from the third pulley, and at what angle, calculate the magnitude and direction of the equilibrant (F_E) by the component method and the graphical method.

Component Method:

On a separate piece of paper, add the vector components of force A and Force B to determine the magnitude of the equilibrant. Use trigonometry to find the direction (remember, the equilibrant is exactly opposite in direction to the resultant). Record the results in Table 1.

Graphical Method:

On a separate piece of paper, construct a tail-to-head diagram of the vectors of force A and Force B. Use a metric rule and protractor to measure the magnitude and direction of the resultant. Record the results in Table 1. Remember to record the direction of the equilibrant, which is opposite in direction to the resultant.

How do the theoretical values for the magnitude and direction of the equilibrant compare to the actual magnitude and direction?

Table 1 : Results of the three Methods of Vector Addition

Method	Equilibrant (F_E)	
	Magnitude	Direction
Experiment:		
Component: R_x= ________ R_Y= ________		
Graphical:		