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# Force Table

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**Abstract**

A force table apparatus for performing experiments to determine the forces' result comprises a base with leg support forming thereon a tripod. An upstanding post removably held to said base with a lower end provided a level adjuster and the upper end provided a holder. Circular platforms are fixedly held to the holder and secured by a protruding pin locking mechanism. It has numerous clamp jaws arranged adequately along the circumferential edge of the platform. Each jaw includes an opposing elongated slit securely inserted into the edge provided with a rotatable pulley. Stringed weights tied into the pin passing through the slit and hanging into the pulley.

**Keywords**

Force Table Apparatus, Resultant Forces, Scalar Quantity, Vectors, Circular Platform, Jaws, Weights

## Introduction

The present utility model pertains to an apparatus for experimenting on the resultant of forces (Newton, 1600) in x-engineer.org (2020) using light yet sturdy materials and with easily assembled, dismantled, and stacked parts.

Scalars Hamilton (1846) in physicsclassroom.com (2021) are quantities with only quantities such as 250, Php 30.00, and 5 litres of gasoline. Vectors used extensively in physics are quantities that possess both magnitude and direction. A force is an example of a vector quantity of 57 newtons due east.

An arrow can represent a vector. The length of the arrow represents the magnitude of the vector, while the arrow tip represents its direction. The handwritten notation for a vector is an arrow above the letter. In printing, it is represented by a boldface symbol or a boldface symbol with an arrow above it.

Coplanar vectors are vectors lying on the same plane. The vectors' addition (or composition) gives the resultant (**R**). It is a single vector whose effect is the same as any set of vectors. An anti-resultant is equal in magnitude but opposite in direction to the resultant. When forces are the vectors used, it is called the equilibrant (**E**).

A body is said to be in equilibrium when the vector sum of all the forces on it is zero ($\sum \mathbf{F}=\mathbf{O}$). When many forces are acting on a body, equilibrium is attained. Especially, by applying the equilibrant equal and opposite to the resultant of these forces. When the body is at rest, it is in static equilibrium.

When the vectors have the same line of action, the magnitude of their resultant is an algebraic sum. When they do not have the same line of action, their resultant may be determined by graphical or analytical methods. Both methods make use of the fact that a vector can be slid along its line of action or translated parallel to it without any change in its effect when both its magnitude and direction are unchanged. The law of commutations (**A**+**B**=**B**+**A**) and the law of associations ((**A**+**B**) + **C** = **A** + (**B**+**C**)) are obeyed in vector addition.

The graphical method involves the drawing of vectors according to scale. For two vectors, say **A** and **B**, the resultant **R**=**A**+**B** is determined by the parallelogram and triangle methods. In the parallelogram method, **R** is obtained by constructing a parallelogram with **A** and **B** as sides and drawing. The concurrent diagonal with its tail and tip coincides with A's tail and the tip of B, respectively.

The B'**s** tail is placed at the tip of **A**. **R** is drawn from A's tail in the triangle method, the first vector, to the tip of **B**, the second (and last) vector.

For more than two vectors, the parallelogram method involves finding the resultant of one pair, using this resultant with the next vector, and so on. A quicker way is to employ the polygon (not the triangle anymore because three or more vectors are involved now) method. The given vectors are drawn in succession tip-to-tail. **R** is drawn from the tail of the first vector to the tip of the second (and last) vector.

The analytical method uses trigonometry to solve for the resultant. For two vectors, **R** is determined by using the law of cosines and the law of sines. In the case of three or more vectors, the rectangular resolution (or component) method is more convenient. This method involves the resolution of each vector into rectangular (or orthogonal) components along with a suitable pair of axes. Commonly chosen are the Cartesian (or XY) axes for coplanar vectors. Take the case of vectors **A**, **B** and **C**.

The components of **R** are such that $R_x=A_x+B_x+C_x$ and $R_y=A_y+B_y+C_y$. The magnitude of R is obtained using the Pythagorean equation. The angle R specifies its direction with the x or y-axis or with any given vector.

The resultant can be verified experimentally using the force table through graphical and analytical methods. Forces are vectors useful for experiments because they are set up and controlled quickly. If a particle acted upon by several forces is in equilibrium, then the sum of these forces is zero. Any one of the forces is the equilibrant of the others. Once identified, the resultant of the other forces can also be determined as the vector equal but opposite to it.

The force table makes use of concurrent, coplanar forces. Its circular platform is mounted horizontally and levelled carefully at the outset. The "particle" upon which the forces act is a ring placed at the centre of the table. Forces are applied to the "particle", utilizing light strings that pass over the pulleys clamped around the table's edge.

A weight holder may be hung from the loop of the free end of the string, and its weight is included as part of the force. A pin prevents the motion of the ring while the forces are being applied. The ring is balanced under the action of the forces when the pin is both the centre of the ring and the force table. To achieve equilibrium with a minimum of friction, the ring is displaced slightly in various directions and is in equilibrium when observed to return to the centre of the table. The direction of each force is read from the table's circular scale. One force is identified as the equilibrant of the others and from this datum, the magnitude and direction of the resultant of the other forces is determined.

Available in the market are various designs of the force table, but most are costly and cumbersome. The current method of our force table has a slim and durable stand, light and sturdy circular platform, and efficient pulley holders. Various parts of the apparatus are detachable, offering ease in assembling and dismantling and convenience in storing, transporting and stacking. This utility model conveys many advantages due to its features by doing experiments in mechanics, specifically on vectors, which are precise, efficient, easy and convenient.

**Synthesis**

The force table makes use of concurrent, coplanar forces. Its circular platform is mounted horizontally and levelled carefully at the outset. The "particle" upon which the forces act is a ring placed at the centre of the table. Forces are applied to the "particle", utilizing light strings that pass over the pulleys clamped around the table's edge.

A weight holder may be hung from the loop of the free end of the string and its weight is included as part of the force. A pin prevents the motion of the ring while the forces are being applied. The ring is balanced under the action of the forces when the pin is both the centre of the ring and the force table. To achieve equilibrium with the minimum of friction, the ring is displaced slightly in various directions and is in equilibrium when observed to return to the centre of the table. The direction of each force is read from the table's circular scale. One force is identified as the equilibrant of the others and from this datum, the magnitude and direction of the resultant of the other forces is determined.

The present utility model's primary objective is to provide a table apparatus for determining resultant forces (vectors) during experiments. It is a slim and durable apparatus with efficient pulley holders that provides precise experimental data on vectors (forces). The parts of the apparatus are detachable, making it easy to assemble and dismantle and offering convenience in storing, transporting and stacking.

The present utility model conveys many advantages due to its features by making experiments in mechanics, especially vectors, efficient, easy and convenient.

**Significance of the Study**

The present utility model is a table apparatus for determining or performing physics experiments on resultant forces. A suitable table apparatus is disclosed in the current utility model made of laminated smooth material as its circular platform and other components.

## Objectives of the Study

Generally, this study aimed to design and fabricate Force Table. Specifically, this study aimed to (1) design and fabricate a force table; and (2) evaluate the operating performance of the device.

## Summary of Inventions

The present utility model pertains to an apparatus for experimenting on the resultant of forces using light yet sturdy materials and easily assembled, dismantled, and stacked parts.

The force table makes use of concurrent, coplanar forces. Its circular platform is mounted horizontally and levelled carefully at the outset. The "particle" upon which the forces act is a ring placed at the centre of the table. Forces are applied to the "particle" employing light strings that pass over the pulleys clamped around the table's edge.

A weight holder may be hung from the loop of the string's free end and its weight is included as part of the force. A pin prevents the motion of the ring while the forces are being applied. The ring is balanced under the action of the forces when the pin is both the centre of the ring and the force table. To achieve equilibrium with the minimum of friction, the ring is displaced slightly in various directions and is in equilibrium when observed to return to the centre of the table. The direction of each force is read from the table's circular scale. One force is identified as the equilibrant of the others and from this datum, the magnitude and direction of the resultant of the other forces is determined.

The present utility model's primary objective is to provide a table apparatus for determining resultant forces (vectors) during experiments. It is an apparatus that is slim and durable with efficient pulley holders that provides precise experimental data on vectors (forces). The parts of the apparatus are detachable, making it easy to assemble and dismantle and offering convenience in storing, transporting and stacking.

The present utility model conveys many advantages due to its features by making experiments in mechanics, especially vectors, efficient, easy and convenient.

## Brief Description of the Drawing

Figure 1 is a front elevational view of the present utility model for a table apparatus for determining resultant forces.

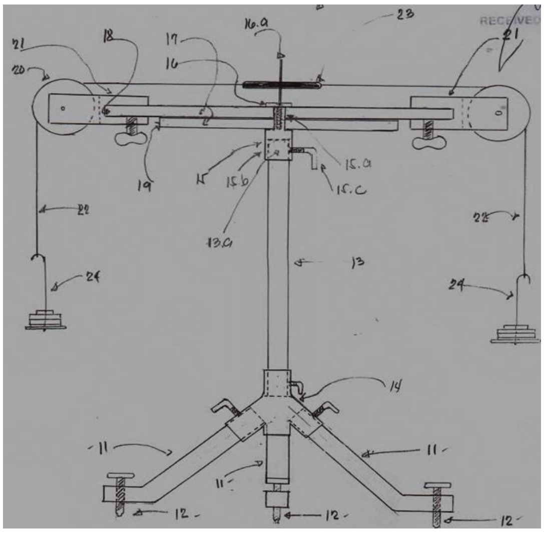

**Figure 1**

**Description of the Preferred Embodiment**

A preferred embodiment of the force table 10 is shown in Figure 1. The table apparatus 10 comprises a base 12 defining a tabular connecting member 14 having a central tubular section 16 and a plurality of tubular extensions 18. Each of said tabular extensions 18 is inserted with the leg support 20 and is securely locked by an L-shaped screw LS. The leg supports 20 and is made of metal with a bent portion 22 at its end and provided with a level adjuster 24 adapted to contour uneven ground surfaces. The base 12, therefore, forms a tripod.

The central tubular section 16 of said connecting member 14 is inserted with an upstanding post 26 removably held and securely locked by an L-shaped screws LS. The connecting member 14 stably secures the leg supports 20, and post 26 extends on its upper end. The post 26 is provided with a table holder 28 having a tabular cap 30 adapted to receive the upper end of the post 26 and securely lock by an L-shaped screw LS. Extending from the said cap 30 is a tubular stud 32 with a threaded inner portion 34. A locking mechanism 36, preferably a screw with a substantially flat head diameter equal to the tubular cap 30.

The table holder 28 supports a pair of circular platforms 38, 40 serve as the table for determining the resultant forces. Platform 38 is broader in diameter and made of a transparent material, preferably fibreglass or glass. Platform 40 has a narrow diameter compared to platform 38, and positioned in between said platform is a graduated memeber42. These platforms 38, 40 are provided with a central aperture44 at its central vertex that will be inserted and held into the tabular stud 32 of the holder 28 and screwably and fixedly secured by the locking mechanism 36. The tabular cap 30 of said table holder 28 serves as a shoulder to support the platforms.

The centre uppermost portion of the said locking mechanism 36 is a pin 46 with its lower end snugly fitted into a cavity disposed of on said locking mechanism 36. The upper portion of pin 46 protrudes and acts as the marker during the experiment to determine resultant forces.

A plurality of clamps jaws 48 are spaced arranged along the circumferential edge of platform 38. As shown in figure 4, each clamping jaw 48 includes an elongated horizontal slit 50 disposed at its distal end and an elongated vertical slit 52at its other end. The horizontal slit 50 is adapted to be inserted into the circumferential edge of the broader platform 38 and scerwably secured by a wing nut WN. The vertical slit52 is provided with a rotating pulley 54 having a conventional ball bearing (not shown) wherein the resultant weight forces are hanged thereon.

A plurality of stringed weights W as the weight forces are attached and tied into a ring 56 held to said protruding pin 46. Each of the stringed weight W is hung into the rotating pulley and the clamp jaws 48 are loosely attached to the edge of the platform 38 through horizontal slit 50 and are adapted to move along the edge during the experiment and are secured by a wing nut when equilibrium is established.

In operation, the plurality of clamped jaws 48 is inserted around the edges of the wider platform 38 and are moved freely along the edges of the said platform until such time that equilibrium is attained as per determined by the ring ("particle")with the pin 46 as its centre. Through this setup, the equilibrant (E) is identified and the resultant(R) is determined as equal and opposite to it through the graduated member 42.

**Results**

1. A table apparatus for determining resultant forces comprising:

(a) a base defining a tabular connecting member having a central section and a plurality of tabular extensions, each of the said extensions is securely provided with leg support forming thereon a tripod;

an upstanding post removably held to said central tubular section having upper end provided with a holder;

(b) a pair of circular platforms held to the said holder and fixedly secured by a locking mechanism having a protruding pin;

(c) a graduated circular member fixedly held in between said circular platforms;

(d) a plurality of clamp jaws arranged along the circumferential edge to one of said platforms. Each jaw includes an opposing elongated slit wherein one of the said slits is securely inserted into the said edge and the other slit provided with a rotatable pulley; and

(e) a plurality of stringed weights attached to a said pin and hang to each pulley.

2. A table apparatus as claimed in claim 1, wherein each leg support includes a bent end with a level adjuster adapted to contour into the ground.

3. A table apparatus claimed in claim 1, wherein said pair of circular platforms are laminated.

4. A table apparatus as claimed in claim 1, wherein one of said circular platforms is wider in diameter over the other.

5. A table apparatus claimed in claim 4, wherein said wider platform is made of transparent material adopted to provide transparency to said, graduated member.

6. A table apparatus as claimed in claim 1, wherein said pin protrudes at the central portion and is adapted to be provided with a ring wherein stringed weights are tied thereon.

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