Forces and Static Equilibrium

Objectives:-

1- To study forces in static equilibrium.
2- To find the force $\mathbf{F_3}$ graphically.
3- To find the mass of unknown object by utilizing the force requirements of equilibrium and vector algebra.

Theory:-

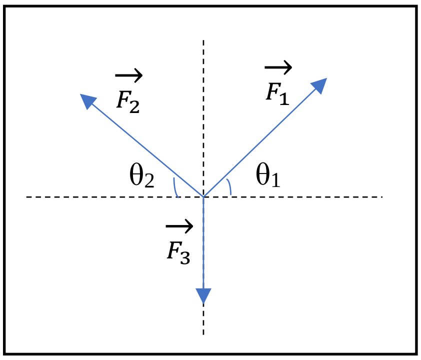
Newton's First Law states that when a body is in equilibrium there can be no net force acting on an object, or in other words **the vector sum of all the forces** must be **zero.**

$$\Sigma F = 0$$

In a two-dimensional case, this vector equation is equivalent to two scalar equations:

$$\Sigma F_x = 0 \qquad \Sigma F_y = 0$$

so, if we have three forces as in figure the equilibrium conditions will be:



along the ***x*-direction** $\quad F_1 \cos\theta_1 - F_2 \cos\theta_2 = 0$

along the **y-direction** $\quad F_1 \sin\theta_1 + F_2 \sin\theta_2 - F_3 = 0$

Where,

$$F_1 = m_1 g \qquad \text{and} \qquad F_2 = m_2 g$$

Apparatus:-

Board	Cables
Dynamometer	masses
Small pulleys	

Procedure:-

1. Prepare the system. Make sure that the string is throwing the pulleys, 0 scale of the board is horizontal and reading of dynamometer is zero.
2. Put equal weights $\mathbf{m_1}$ **and** $\mathbf{m_2}$ in the hangers, these weights represent F_1 and F_2 where,

$$\mathbf{F_1 = m_1 g} \qquad \textbf{and} \qquad \mathbf{F_2 = m_2 g}$$

3. Move the **dynamometer** left and right until it becomes **vertical** which represent the equilibrium state.

4. By using the board find out the angles between **F_1 and the positive x-axis (θ_1)**, and the angle between **F_2 and negative x-axis (θ_2)**.

5. Record the dynamometer reading **F_3** (experimental).

6. Choose a scale to represent the vectors **F_1** and **F_2**.

7. Draw **F_1** and **F_2** (by using the scale of diagram).

8. Measure the length of the line that represent the vector F_3 by a ruler then use the diagram scale to find the magnitude of F_3 graphically in Newton.

F_3 = (length F_3 × diagram scale)

9. Compare between **F_3 experimental** and **graphical.**

10. Repeat steps 1,2 and 3 for unknown mass.

11. Find the mass of unknown object by using the **equilibrium conditions**.