FORCES IN EQUILIBRIUM

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Physics Lab #1

Purpose:

To prove that when three concurrent forces are in equilibrium, each force is the equilibrant of the other two.

Theory:

A very basic concept when dealing with forces is the idea of equilibrium, or balance. In general, an object can be acted on by several forces at the same time. A force is a vector quantity which means that it has both a magnitude (size) and a direction associated with it. If the size and direction of the forces acting on an object are exactly balanced, then there is no net force acting on the object and the object is said to be in equilibrium. Because there is no net force acting on an object in equilibrium, then from Newton's first law of motion, we know the object will stay at rest.

In the case of our lab, we saw that when there was a composition of vectors, each with a different angle, there was no net force. Based off of our observations, and proven by Newton's first law of motion, we know this is true, as we saw that the springs did not move. However, there is another component that we dealt with, which was the equilibrant. The equilibrant, (which was the resultant, or diagonal once we drew a parallelogram connecting each vector/angle) is a third force in between the other two forces that cancels out the two forces, resulting in a vector sum of zero, otherwise known as equilibrium.

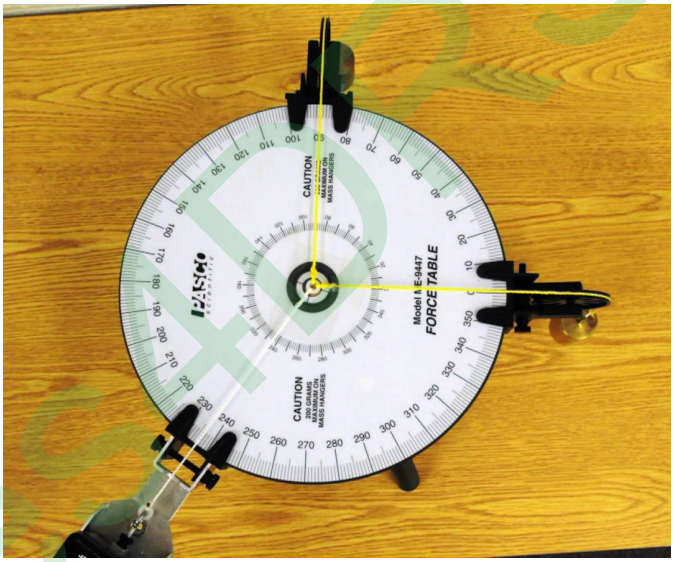
Materials:

- A notched force board
- Three spring scales pulling on a common ring
- Ruler
- Protractor

Procedure:

1. Set up apparatus as shown in diagram
2. Trace edges of each spring scale and record its reading
3. Draw a line through the middle of each sketch until they intersect at the center of the paper
4. Using a scale of 1cm = .5cm, draw vectors outward from the point of intersection in each direction
5. For each pair of forces, complete the parallelogram and then draw the diagonal
6. Compare the length of the diagonal to the equilibrant
7. Calculate the percent error

Diagram:



Calculations and Results:

$$\text{Percent Error} = \frac{\textit{Original Force} - \textit{Resultant}}{\textit{Original Force}} \times 100$$

Force A $\frac{6.4 - 6.4}{6.4} \times 100 = 0\%$

Force B $\frac{6.4 - 6.6}{6.4} \times 100 = 3.125\%$

Force C $\frac{7.5 - 7.0}{7.0} \times 100 = 7.14\%$

Conclusion:

In this lab, the theory that when there are three concurrent forces on a common ring, which are all in equilibrium, each force is the equilibrant of the other two was proven. Our calculations proved as well that the equilibrant force between the angles cancelled out the other two forces, resulting in equilibrium. While there was a slight percent error when calculating the difference between the original force and the resultant, this does not invalidate the results, as a slight percent error is expected in all experiments. As we are human, we are imperfect and therefore minor errors can be expected when calculated results. The percent error was most likely due to inaccurate readings of the different measurements. To obtain more precise results, an advanced tool that can precisely measure could be used, instead of the basic ruler and protractor that was used.