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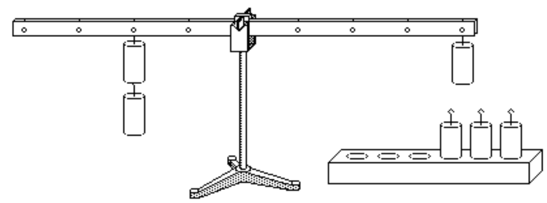
Lab # 12 – Law of the Lever

Purpose

The purpose of this lab is to identify variables which may be used to help to balance a lever.



Procedure

We *cannot* assume that the meter stick we are using has a perfectly even distribution of mass, meaning that the center of gravity is located in the geometric center of the stick. First you will have to identify the correct location of the center of gravity of the meter stick. The goal is to try to find a relationship between the location of a placed weight and the likeliness for the meter stick to begin rotating. Just having the meter stick balance on its own is kind of boring though, so let's try to make things interesting by adding multiple weights on each side to see different combinations in which we could balance the system.

Data

1) In the table below, try a couple combinations of weight distribution by placing a single weight on one side of the torque beam and balancing it by placing another, ***NON-IDENTICAL***, weight to the other side at a location of your choosing. Once you have a successful balance, record the values or Object A (left side of the torque beam) and Object B (right side of the torque beam). ***Note that the mass of each hangar is about 16.8 g, which must be included when calculating the weight.***

Location of Pivot on Meter Stick after balancing: $x_{center\ of\ gravity}$ = **49.2m**

Weight A (N) F_{g_A}	Distance From Pivot (m) r_A	Weight B (N) F_{g_B}	Distance From Pivot (m) r_B
5064.64	10.85	1438.64	39.2
1634.64	10.85	458.64	39.6
948.46	10.85	262.64	40.1

a) Explain, in words, a relationship that you saw between the weights and the distances from the pivot to assure balance.

Depending on where the weights were placed in respect to the pivot, the meter stick would fall in a certain direction. Along with this if there were heavier weights being placed close to the pivot, more weights would be needed to be on the other side of the pivot to balance the meter stick.

b) Is there perhaps some mathematical relationship you can formulate using the variables, F_{g_A}, r_A, F_{g_B}, r_B?

The mathematical relationship I can use is Fga*ra= Fgb*rb.

2) Now let's make things more interesting! On the left side, hang two masses at locations of your choice. On the right side, use only one mass and try to balance the apparatus.

$F_{g_{A_1}}$	r_{A_1}	$F_{g_{A_2}}$	r_{A_2}	$F_{g_{B_1}}$	r_{B_1}
20.8	360.64	10.85	654.64	360.64	41.2

a) Could you build on the equation from 1b, and create another that includes all 6 variables in the table above?

To expand on the formula from 1b, Fga1(ra1)+Fga2(ra2)= Fgb1(rb1)

3) Let's put your skills to the test! Adjust the meter stick's position on the stand to where the equilibrium point on the meter stick is no longer at the pivot. Since the meter stick is of uniform mass, you can assume that all of the weight of the meter stick is acting at a single point on the location of the center of gravity. Use what you have discovered to try to calculate the weight and mass of the meter stick.

Remove all hanging weights except for one and try to rebalance the meter stick. Consider the weight of the meter stick acting at the 50 cm mark on the meter stick, and estimate the mass of the meter stick using your equations above.

Added Weight (N) $F_{g_{added\ mass}}$	Distance From Pivot (m) $x_{added\ mass}$	Weight of Meter Stick (N) $F_{g_{meter\ stick}}$	Distance From Pivot (m) $x_{meter\ stick}$
654.64	10.85	**0.90784**	54

$$F_{g_{meter\ stick}} = 0.90784\text{N}$$

$$m_{meter\ stick} = 0.0926\text{kg}$$

Now measure the true mass on the triple beam and calculate your error.

$$\%\ Error = \frac{|experimental - actual|}{|actual|} \times 100\% = 24.6\%$$