Physics 2A **Center of Mass** **Name: _______________**

Experiment 8 **Lab day/time: ______________**

Purpose: The purpose of this experiment is to develop an understanding for the importance of the center of mass of a system. The location of the center of mass of a system of particles in a state of static equilibrium can be found using the equation:

$$x_{\text{cm system}} = \frac{\sum m_i x_i}{\sum m_i}$$

In order for the system to be in equilibrium, the sum of all torques about the pivot point (fulcrum) must be zero. In other words, the fulcrum must be directly below the center of mass of the system of particles.

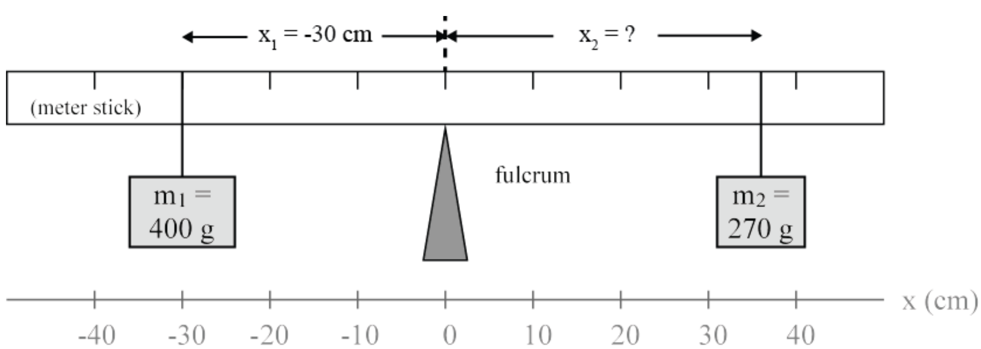
Materials:

- Fulcrum
- Meter stick
- Sleeve for meter stick
- Mass hangers (3)
- Masses

Procedure:

<u>Part A: Hanging Mass – Stick System</u>

1. Measure the mass of your meter stick (without the sleeve) and record it in the column under $\mathbf{m_{stick}}$ in the first table below.
2. Determine the center of mass of the meter stick by carefully sliding it along the metal sleeve until it is horizontally balanced on the fulcrum (be sure that the fastening screw on the metal sleeve is pointed downward). Record your result here: $\mathbf{x_{cm\ stick}}$ = ______________________
3. Use strings, mass hangers, and masses to hang masses on a meter stick with the values given in the table. The diagram below shows the experimental set up for Run #1. Always take the location of the fulcrum as your zero reference point, which implies that $x_{\text{cm system}} = 0$.
4. Determine the experimental value of the missing quantity in the table (x_2 in Run 1) by carefully adjusting this value until the system is in equilibrium. Record this value in the table.
5. Using the equation for $x_{\text{cm system}}$, calculate the theoretical value of the missing quantity (x_2 in Run 1). Record your result in the table under **Theory** and compute the percent difference between experiment and theory.
6. Repeat this general procedure for Runs 2 through 4 in order to determine the values of the remaining missing quantities in the table.



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Part A: Hanging Mass – Stick System

Note: $\mathbf{x_{stick}}$ *is the displacement of the meter stick's center of mass location (*$\mathbf{x_{cm\ stick}}$*) from the fulcrum.*

Run	m_{stick} (g)	x_{stick} (cm)	m_1 (g)	x_1 (cm)	m_2 (g)	x_2 (cm)	m_3 (g)	x_3 (cm)	Theory	% diff
1		0	400	-30	270		N/A	N/A		
2		0	100	25	90	40		-30		
3		-10	120	30	280	35	450			
4		-20	150	-30	350	-45		25		

Be sure to show all your calculations below and explain why there are differences between the experimental and theoretical values.

Part B: Blocks – Stick System

1. Ask your instructor for four blocks (red, blue, orange, green). Measure and record the masses of these blocks in the first table below.
2. Remove the sleeve from your meter stick and place the stick at the edge of your table.
3. Ask your instructor to place the blocks on your meter stick. Do not do this on your own.
4. *Take your zero reference point to coincide with the zero position labeled on your meter stick.* Make a large, neat, scale drawing of the set up below, showing the different colors of the blocks and their positions on the meter stick.
5. Carefully slide the meter stick over the edge of the table until it barely begins to tip over. Record the measured value of the blocks – stick system's center of mass in the table below. *Note: As in Part A, $x_{cm\ system}$ is located at the "fulcrum" or pivot position. However, the value $x_{cm\ system}$ is not equal to zero.*
6. Calculate the position of the center of mass using the equation below. *Be sure to measure the displacement x_i of each object in your system from the zero reference point.* Record this result as your calculated value in the table below.

$$\mathrm{x_{cm}} = \frac{(\mathrm{m_{stick}})(\mathrm{x}_{stick}) + (m_{red})(x_{red}) + (m_{bl})(x_{bl}) + (m_{gr})(x_{gr}) + (m_{or})(x_{or})}{m_{stick} + m_{red} + m_{bl} + m_{gr} + m_{or}}$$

7. Calculate the percent error between the measured and calculated center of mass (use your calculation as the "accepted" value).

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Part B: Blocks – Stick System

m_{stick}	m_{red}	m_{blue}	m_{green}	m_{orange}

	Measured	Calculated	% diff
$\mathbf{x_{cm\ system}}$			

Drawing/Calculation: