Laboratory Investigation Name _____

Physics@Frisch: Form L4.2A Date _____ Period _____

Center of Mass

Problem

How do objects balance?

Introduction

The center of mass is the average location of an object's mass. The center of mass is important because objects balance around it. If you hang an object from a string, the object will rotate so its center of mass is directly below the point of support. Closely related to the center of mass is the center of gravity. The center of gravity is the average location of the force of gravity exerted on an object (its weight). In this investigation, you will locate the center of mass of an object., explain why a stack of books can extend over the edge of a table, and perform two balancing activities using your body.

Materials (*per group*)

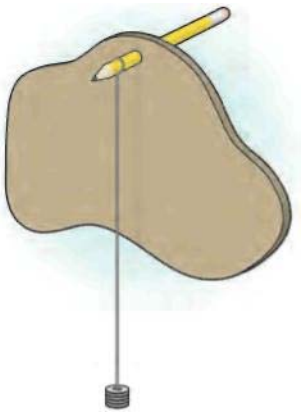
Books (5); Cardboard; Classroom chair; Hole-punch; Ruler; Scissors; String; Washers

Procedure

1. Cut an irregular shape from a piece of cardboard.

2. Make a plumb line by tying a mass or some washers to the bottom of a piece of string. The string should be at least twice as long as the largest dimension of the shape you cut out.

3. Punch a small hole in your shape near the outside edge. Suspend the shape and the plumb line on the tip of a pencil as shown in the diagram at right. The shape should be able to swing freely on the pencil.



4. Carefully trace the path the string makes on the shape.

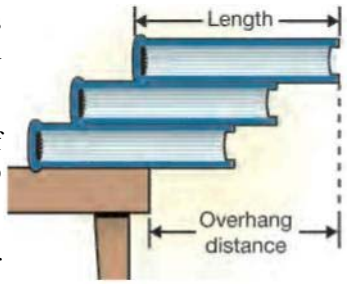
5. Repeat steps 3 and 4 using holes punched at different locations at the edge of the shape. Repeat again for a total of three lines.

6. The three lines should intersect at one point. Make a dark circle at this location. This point is the center of mass of the shape.

7. Remove the shape from the pencil and try to balance the shape on the tip of one finger at its center of mass. Try to balance the shape at other locations by supporting it with one fingertip. Note where it does or does *NOT* balance.

8. Gently toss the shape up into the air in such a way that it rotates while it moves up and then back down. Watch the circle at the shape's center of mass while it spins and notice what it does.

9. Place a book (or, alternatively, a domino or a block) on a table so that it extends over the edge as far as possible without falling. Measure the length of the book and its overhang distance. Record your measurements in the table on the next page.



10. Place a second identical book (or other identical object on top of the first. Adjust the positions of the two books to get the maximum overhang distance. Measure the distance and record. One group member should be ready at all times to catch the books in case they fall off the table's edge.

11. Repeat step 10 with three, four, and five books. Try to achieve the greatest overhang distance for each number of books and measure each distance and record your observations

12. Stand with your back and heels against a wall. Slowly bend down and try to touch your toes. Note how keeping in contact with the wall affects your balance.

13. Position a chair so that it is facing you. Stand with your toes 2 feet away from the front edge of the chair. Bend over at the waist, touch the sides of the chair, and bend your body up to a standing position.

14. Now bend over in the same way but grab the sides of the chair this time. Try to bend upward while holding the chair. Note what happens.

OBSERVATIONS

Length of one book (cm)	Number of books	Overhang distance (cm)
	1	
	2	
	3	
	4	
	5	

CONCLUSIONS

1. Explain why the shape balances at the center of mass but not at other points. _____

_____

2. What does the circle at the shape's center of mass do while it spins? _____

_____

3. If the books are placed so that they have the greatest amount of overhang possible, where is the center of mass in relation to the edge of the table? Explain. _____

_____

4. Describe the relationship between the number of books and the overhang distance. _____

_____

a. How many books had to be stacked to reach an overhang distance of one book length? _____

b. How many books do you think it would take to reach an overhang distance of two book lengths? _____

5. How does standing against a wall affect the activity of bending to touch your toes? Why? _____

_____

6. It's not hard to bend over at the waist, touch the sides of the chair, and bend back up to a standing position, but if you grab the chair and try to stand, it's hard to balance. Why? _____

_____

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