PSC 1121 Celebration of Knowledge 1 Fall 2002 / Dr. Saul

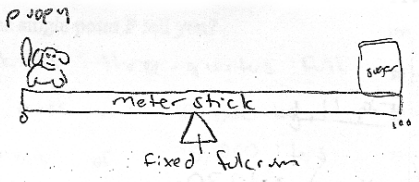
Problem 3 (10 points)

You would like to determine the mass of your new puppy, but you don't have a scale or a balance. While poking around the pantry for a snack you find a 1 kg bag of sugar and a meter stick. Explain carefully how you could use these objects to determine the mass of your puppy.

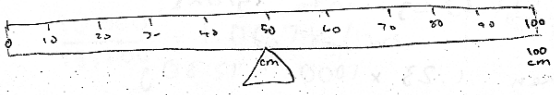
Dr. Saul's comments: Key points

- *Use the meter stick and a fulcrum to make a balance*
- *Placing the puppy on one side of the balance and the bag of sugar on the other, need to adjust puppy and sugar so that system is balanced and turning affects on both sides are equal.*
- *Use M x L (right side) = m x l (left side) to find mass of puppy from mass of sugar and distances of the sugar and the puppy from the fulcrum.*

Student Solution 1:



By using $M_1L_1 = M_2L_2$ we can determine the mass of the puppy. A meter stick is broken into equal sections so this is a standard measurement device.



- Place the fulcrum directly at 50 cm point or directly in the middle of the meter stick. The two sides should balance before starting the experiment.
- Place bag of sugar on right side and puppy on left side at the same distance from the fulcrum (touching both ends is a good place to start)
- Whichever side touches the floor has a greater turning effect so the other side must compensate.

Using $M_1L_1 = M_2L_2$ we can determine mass.

If puppy and bag were equal at this point then the puppy's mass would be: (1 kg X 50 cm) = 50 kg.

If the bag had a greater turning effect in the beginning then the bag must be moved closer to the fulcrum.

Find a point where the bag and puppy balance. Use this point (cm) X 1 kg and mass is found.

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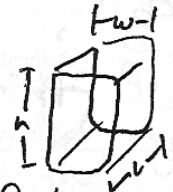
Problem 3 (continued)

The solution on the previous page is pretty good. It definitely hits the key points. However it is hard to follow because it jumps around a bit. In addition, putting the puppy and sugar at the ends of the meter stick may not be the best way to start. A better way might be to place both the puppy and bag of sugar halfway between the fulcrum and the ends. That way we have room to adjust the turning affect of the bag of sugar regardless of which side has the greater turning affect. Explanation of how to use the equation could be clearer.

While I was thinking in terms of a balance, this is not the only way to answer this question. Below is a creative solution using density and volume, instead of a balance. See the Problem 4 solution on how to improve the argument for using density to find mass.

Assuming that your puppy has the same density of a bag of sugar you can . . .

(1) find the exact dimensions of the 1 kg bag of sugar using the meter stick. You will need to find the height x width x length!



(2) Next, you will need to find the exact dimensions of your puppy. To do this, you will have to measure your dog in several different parts (i.e. legs, body, head, etc.) but ALWAYS find dimensions by multiplying height x width x length.

(3) Once you have the cubic dimensions of both your puppy and the bag of sugar, divide the "volume" (cubic dimensions of your dog) by the volume of the 1 kg bag of sugar.

(4) Multiply this quotient by 1 (which represents the mass of the 1 kg bag of sugar), and you will have an estimate of how much your puppy weighs.