2 Smart Ropes

Purpose

To explore mechanical equilibrium

Required Equipment/Supplies

2 digital balances, preferably with a minimum of 1-kg capacity
meterstick
1-kg mass

Discussion

As a former boxer, uranium prospector, and cartoonist, the author of your textbook Paul Hewitt certainly had an unusual route into physics. He was inspired to learn about the subject by a fellow sign painter, Burl Grey, who was a science buff. Hewitt would engage in lively discussions about fascinating topics in science. It was these discussions in part that inspired Paul Hewitt to attend the Lowell Technological Institute in Massachusetts, where he began his physics career at the age of 26 with no scientific knowledge whatsoever.

During one of his discussions with Burl, Hewitt thought about what would happen to the tension in a rope suspended on either end of a wooden plank, like the kind used to suspend sign painters. It seemed reasonable enough that if you stood in the center, the tension of each rope would be the same. But what would the tension in each rope be if the painter walked closer to one rope or the other? Would the tension in the rope near to the painter be greater and the tension in the other, more distant rope, less? If so, how much greater? And how much less would the tension be in the other rope? More importantly, was the amount the tension *increases* in one rope the same as the amount the tension *decreases* in the other? How did each rope "know" how much to change? If so, what makes the ropes so *smart*?

Procedure

Step 1: Place the balances so that they are about 1 meter apart. Turn on the balances and make sure that they read "zero." Carefully position the meterstick so that each end is in the middle of the balance pan.

Step 2: Look at the mass reported on each balance. They should read about the same. Press the tare button. This resets the balance to zero. Doing this enables you to take readings that don't include the mass of the stick.

Position of Mass (cm)	Scale 1 Reading (kg)	Scale 2 Reading (kg)
0		
10		
20		
30		
40		
50		
60		
70		
80		
90		
100		

Step 3: Place a 1-kg mass on the 50-cm mark of the meterstick. Record the mass data reported on each scale in the data table.

Step 4: Move the 1-kg mass to the 40-cm mark. What mass is reported on each balance now? Continue to record mass measurements on each balance as you move the 1-kg mass to the 30-cm mark, the 20-cm mark, the 10-cm mark, and the 0-cm mark.

Step 5: Move the 1-kg mass back to the 50-cm mark. Take mass measurements on each balance as in Step 4, but with the 1-kg mass at the 60-cm mark, the 70-cm mark, the 80-cm mark, the 90-cm mark, and finally the 1-m (or 100-cm) mark.

Analysis

1. Study your data. Do you see a pattern? How does the amount of increase on one scale compare to the decrease on the other? What is the sum of the readings from each scale? Summarize your results below.

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2. Make a "dual" plot line graph—that is, plot the readings from the left scale and the right scale versus the positions on the meterstick on the same graph. Make different data point marks on the graph such as squares for the left balance data and circles for the right balance data. Where do the plots intersect?

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3. Write a generalization that explains why you think this is so.

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