Collapsing Crane Preliminary Lab

Physics

For the final Collapsing Crane Lab, you will need to determine the location of a fixed-mass counterweight for a tower crane model. In order to do this, you will need to incorporate the physics equations for rotational static equilibrium.

In this preliminary lab, your goal is to develop a general equation that you can use to calculate the location of the counterweight. To do so, follow the instructions below – and make sure that at each step along the way, you are thinking carefully about rotational equilibrium, the equations we've discussed in class, and how the cranes you are working with illustrate the physics concepts we are studying. Work with 2-3 partners and make sure you are all participating equally in the activity.

Part I: ***Simple Rotational Equilibrium***

1. Using the golf hole flags, a clamp, and a wooden dowel, create a crane tower. Using string, hang weights of different sizes on both sides of the tower under conditions of rotational equilibrium. Conduct at least four trials, using a variety of weights, and record the size and location (from where, do you think?) of each weight in a data table.
2. With your partners, discuss your data and any patterns you see. Using the basic equation for rotational equilibrium, come up with a general formula for balancing any weight on one side of the crane with any fixed-mass weight on the other side of the crane. Record this equation in your notes. (The equation is not going to be perfectly accurate; you will need to incorporate a +/- adjustment – discuss with your partners the reasons why!)

Part II: ***Complex Rotational Equilibrium***

1. Modify your crane tower so that it is mounted on a ring stand base and pole. Arrange the arm of the crane so that the long end of the arm is over the long end of the base.
2. As you did above, conduct a series of trials with a variety of weights that result in rotational equilibrium. Imagine that the load being lifted by your crane is attached towards the end of the long arm and the counterweight should be attached to the short arm and set up your trials accordingly (i.e., make sure your crane doesn't tip over backwards!). Record your data in a table.
3. While you may see some patterns in your data, it is likely that you will not be able to create a general equation as easily as you did in the simple equilibrium case above. With your partners, discuss the reasons for this and document your understanding in your notes. What is the most important piece of information that you are missing in order to make your equation work, and why? (Hint – where does the crane tip and how does the base move like as it tips?)
4. Working with your partners, other groups, and your teacher (which might be essential), revise your equation to take the complexity of your crane into consideration. Test your equation with a few different loads and counterweight positions to make sure it works accurately. Record this equation in your notes.