Laboratory #3
Newton's Third Law

Part A. Tug O' War

Concepts
Newton's 3rd law; Newton's 2nd Law; Tension; Forces; Force of Gravity

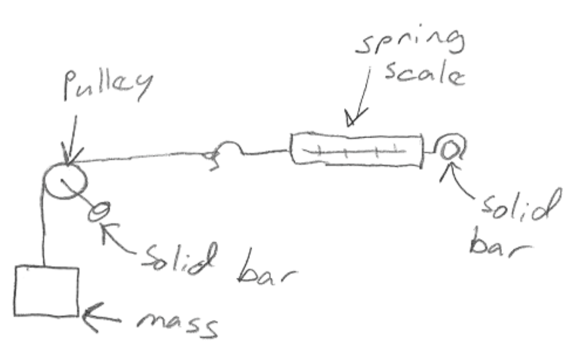
Introduction
Have you ever noticed that when you play tug o' war, the rope in the middle pulls in two directions? It pulls you toward your opponent and your opponent towards you. From this observation we can tell that tension (the force that makes the rope taut) always acts in 2 directions. Newton's 3rd law says that forces always come in pairs (equal and opposite) and ropes always pull from both sides which means that whenever there is a rope involved, there are 4 forces that you have to keep track of: 1) you pull on the rope; 2) the rope pulls on you; 3) the rope pulls on your opponent; and 4) your opponent pulls on the rope. What a mess! This experiment will help clarify all these forces and how they interact.

Necessary Equipment
2 threaded aluminum beams
2 aluminum beams
2 clamps
2 beam mount pulleys
2 mass hangers

6 100 gram masses
1 50 gram masses
3 spring scales
1 hanging pulley
1 spool of string
1 scissors

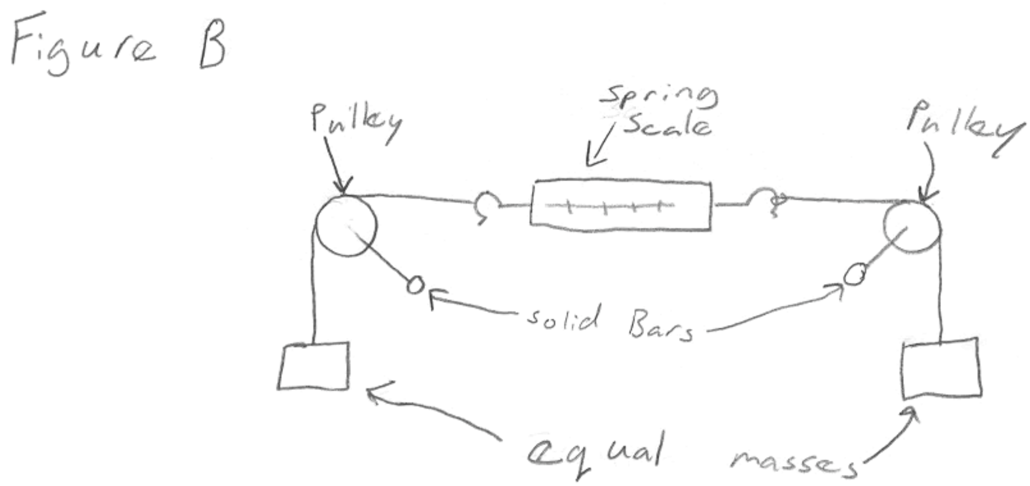
Procedure
- Look at Figure A. Decide how much mass you are going to hang from the pulley. Predict the tension that the scale will read and record it on the chart.

Figure A

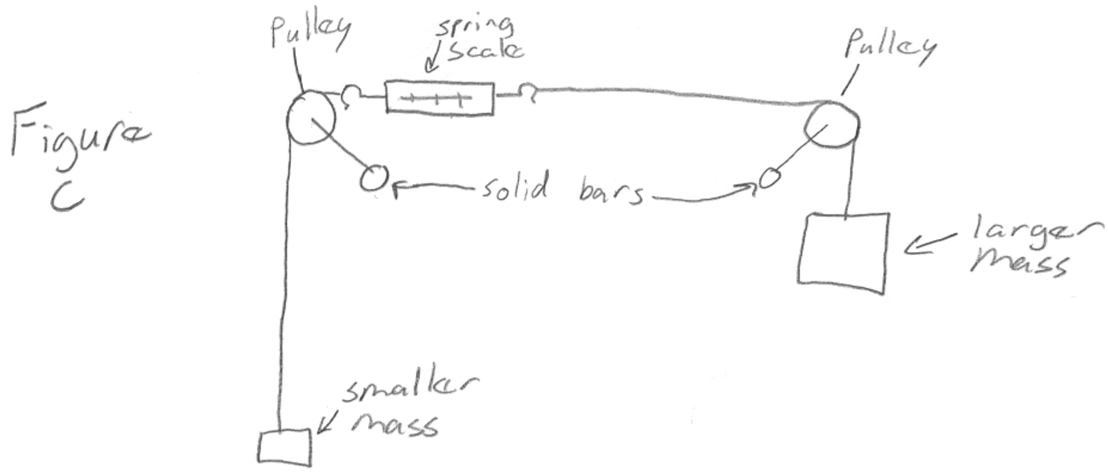


- Set up the pulleys, scales and weights as shown in Figure A.
- Record the information in Table I.

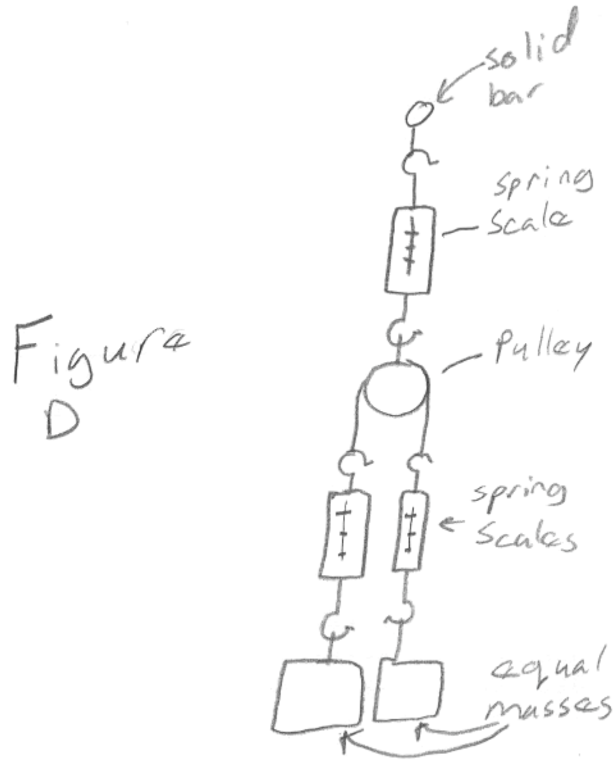
- Answer Questions #1 & #2.
- Look at Figure B. Use the same mass you used in Figure A for each of these masses. Predict the tension that the scale will read and record it on the chart.



- Set up the pulleys, scales and weights as shown in Figure B.
- Record the information in Table I.
- Answer Question #3 & #4.
- Look at Figure C. Decide how much mass you are going to hang. Predict the tension that the scale will read and record it on the chart.



- Set up the pulleys, scales and weights as shown in Figure C. NOTE: This system will move, so be quick while you read the scale!
- Record the information in Table I.
- Answer Question #5.
- Look at Figure D. Decide how much mass you are going to hang. Predict the tension that each scale will read and record it on the chart.



- Set up the pulleys, scales and weights as shown in Figure D.
- Record the information in Table I.
- Answer Question #6.

Part B. Elevator Diet

Concepts
Newton's 3rd Law; Support Force

Introduction
You've heard of those fad diets that promise to "eat nothing but meat for 6 weeks and lose 15 pounds." Of course they neglect to mention how it will negatively affect your body's metabolism and how fast you will gain it back. Today, you will watch the pounds drop off before your eyes, all done by simply riding an elevator. You'll love the look in your friends' eyes when you tell them "I lost 15 pounds this morning just by riding my elevator!" The bad news is that you will gain all the lost weight back within 30 seconds.

Procedure

- Stand on the scale and weigh yourself.
- Take the Parker Hall elevator to the top floor (3 R).
- Observe the places (there are 2 places) that your weight seems to change, and note which way it changes (gains weight or looses weight).
- Take the elevator to the first floor (1 F), while you are on the scale.
- Observe the places (there are 2 places) that your weight seems to change, and note which way it changes (gains weight or looses weight).
- If you missed it, do it again.

Lab Reporting Sheet Laboratory #3	Name:____________________ Date:____________________

Part A: Tug O' War

Set Up	Mass Hung		Predicted Tension			Actual Tension Reading		
A	250g							
B	250g	250g						
C	350g	400g						
D								

1. What is tension?

2. What force is causing this tension? How do we find that force?

3. What is the crazy thing about this set up?

4. What is the important lesson that you need to learn from this set up?

5. In general how could you find the tension in this set up?

6. The top scale probably read more than what you predicted, why would this be?

7. You should notice that the bottom scales have the same reading, why?

Part B: Elevator Diet

- **Using the picture at the bottom of the following page, draw (and label) the force you exert on the scale, and the one that the scale acts on you. Does this pair of forces obey Newton's 3rd Law?**

- **Using the pictures at the top of the following page, label the locations on the path of the elevator where the scale said you lost weight and where you gained weight.**

- **<u>Define</u> acceleration**

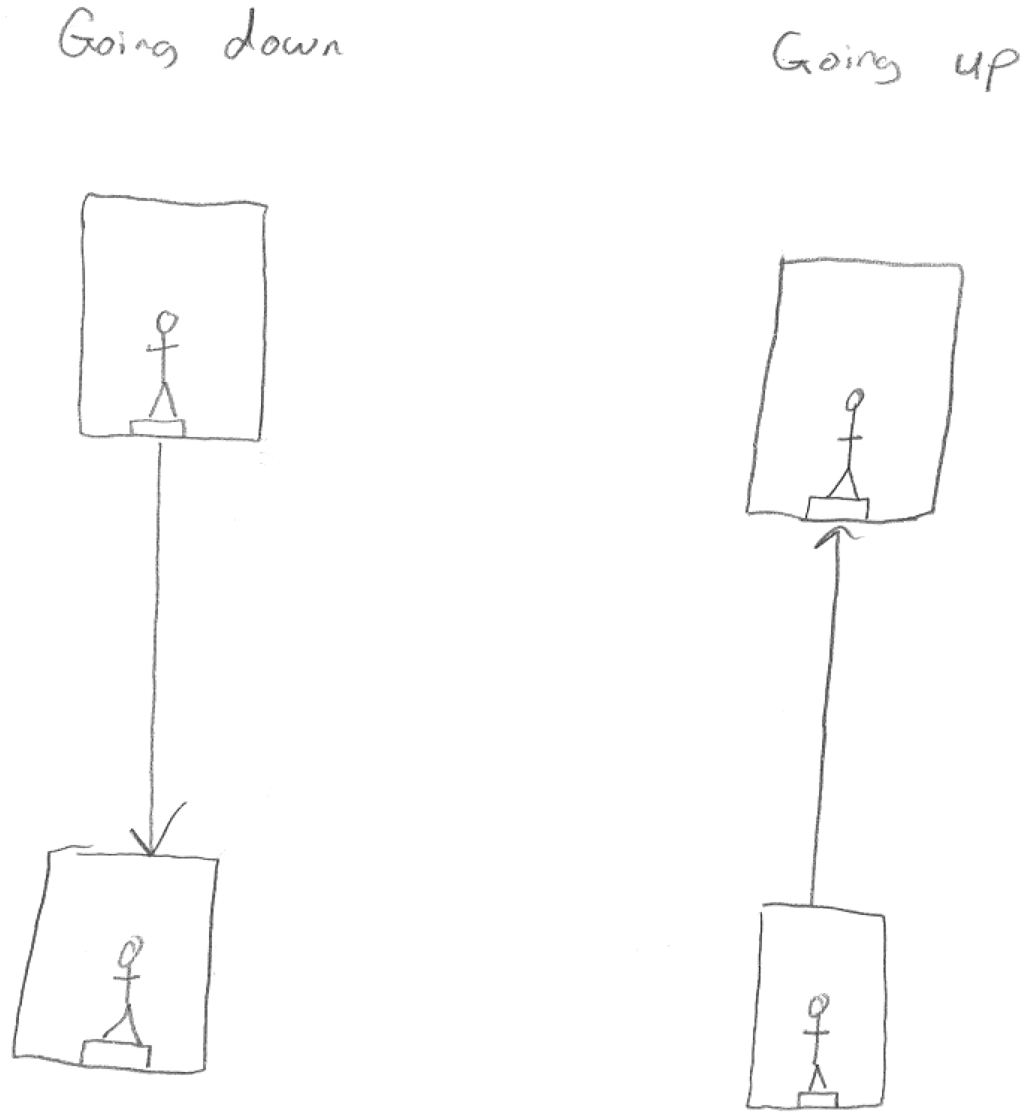
- **On the picture in the second question, label the places where the elevator is accelerating downward and the places where it is accelerating upward. Make sure your answers are correct with your instructor before moving on.**

- **What does the scale read--your Force of Gravity (which is commonly called 'weight' and is mass times the acceleration of gravity on earth) or the support force? (NOTE: this is a multiple choice question!)**

- **In the locations where the support force is less than the force of gravity, what is the elevator doing? What does this have to do with Newton's 2nd Law?**

- **In the locations where the support force is more than the force of gravity, what happens to you? What does this have to do the Newton's 2nd Law?**

- **In the locations where the support force equals the force of gravity what happens to you? Is this consistent with Newton's 2nd Law? Explain.**


Going down
Going up