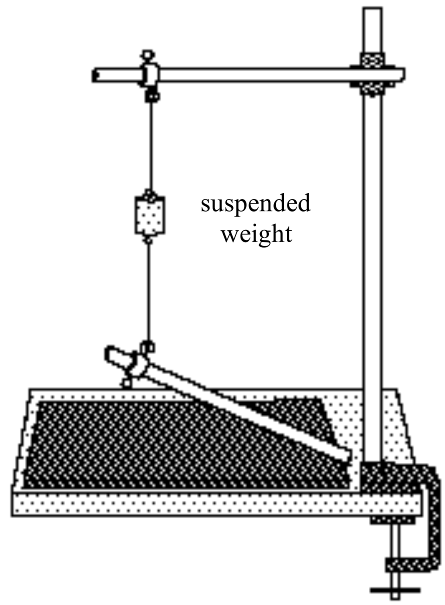
Lab 1a: Inertia and Mechanical Equilibrium
Essentials of Physics: PHYS 101



Setup: Construct the apparatus shown at right.

Prediction: If you were to gradually increase the downward force on the lower rod in the figure until the string breaks will the break occur above the suspended weight or below it? Why do you think this?

Observation: Try it! Record what you observed.

Revision: If your observations are inconsistent with your prediction and reasoning try to create a better explanation for what happens and why.

Prediction: If instead of gradually increasing the downward force you were to increase it suddenly would the result change from the first case. Why do you think this?

Observation: Replace the broken section of string and try applying a sudden downward force (watch your fingers!) Record your observations.

Revision: If your observations are inconsistent with your prediction and reasoning try to create a better explanation for what happens and why. Make sure that your explanations for the two cases do not contradict each other.

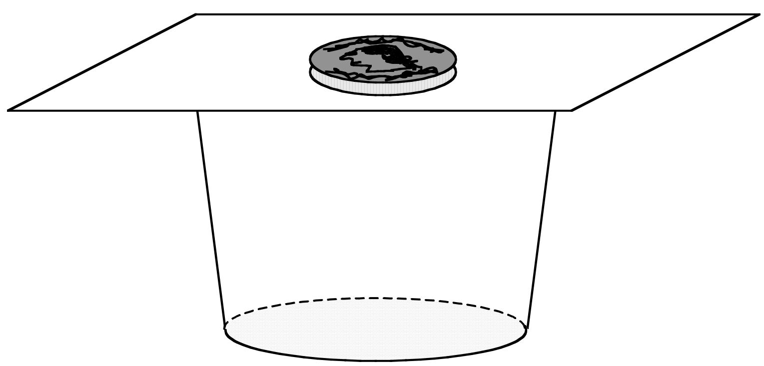
Application: What do these experiments have to do with using toilet paper? (Keep it clean please!)

Lab 1b: Inertia and Mechanical Equilibrium
Essentials of Physics: PHYS 101

Introduction: A classic trick performed by magicians is the tablecloth trick. The magician usually has a table set on stage as if for elegant dinner. Picture steaming plates of pasta with marinara sauce, thick luxurious tablecloths, stemware and silver. If the magician is brave the scene might even be completed by having a couple dressed in tux and evening dress seated at the table. Perhaps the magician, playing the role of a stuffy maitre 'd notices a spot on the tablecloth that simply cannot be tolerated. To remedy the problem she grabs the edge of the tablecloth and dramatically wisks it off of the table without upsetting a single item. As the couple resumes their romantic dinner the audience roars with applause.

Now picture the same scene but replace the magician with a clown. Most likely you envision a quite different outcome involving a not so happy couple who will certainly insist that the clown pay for the dry cleaning bill! Without claiming that the magician actually used "magic" how can we explain the dramatic difference between these two scenes? We will now investigate some simplified versions of the tablecloth trick to find out.

Setup: Place a quarter and an index card over a cup as shown.

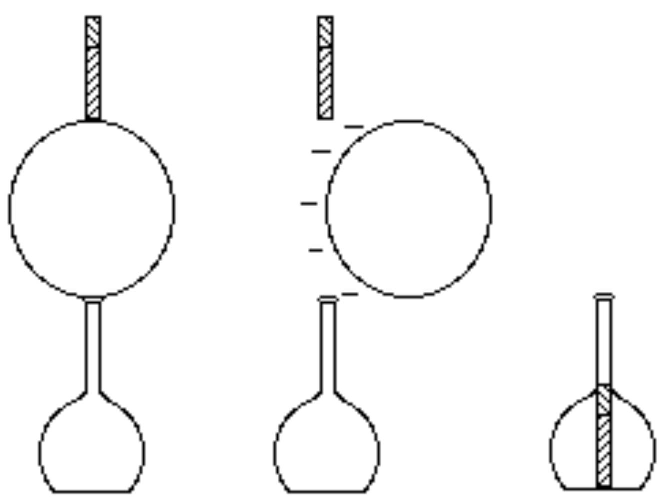


Prediction: If the index card is removed what will happen to the quarter? Will it depend on how you remove the card?

Observation: Try both cases you discussed in response to the previous question. Record what you observed. One good way to remove the card very quickly is to flick the edge of it with your finger.

Revision: If your observations are inconsistent with your prediction and reasoning try to create a better explanation for what happens and why.

Procrastination: You can try another version of the tablecloth trick using a pen, a wooden hoop and a narrow necked flask. This one is a bit trickier than the first so it is set up in the front of the room. Ask your multi-talented lab instructor to help you out when you are ready for it.



Application: Back to the tablecloth trick. What do you think the difference is between what the magician does and what the clown does in trying to remove the tablecloth? If you were going to try the tablecloth trick (at your own risk and with your own dishes!) what could you do to improve your chances of a successful performance?

Lab 1c: Inertia and Mechanical Equilibrium
Essentials of Physics: PHYS 101

Introduction: Whether we like it or not everyone has stood on a scale to be weighed at some point. When you weigh yourself on a scale you remain still or at rest. Since your state of motion is not changing you are in mechanical equilibrium. This means that there must be **zero net force** on your body. We know that gravity always pulls us towards the earth and this is what gives us weight. But if there is zero net force on our body we realize that the ground must push up on us with a **support force** that exactly balances our weight. When you stand on a scale the dial displays the amount of support force that the scale is exerting on your body. This support force is equal to your weight but in the opposite direction.

Setup: Have one (willing) person stand on a bathroom scale to be weighed.

What is the support force reading on the scale?

How much does this person weigh?

What is the net force on the person?

What is the net force on the scale?

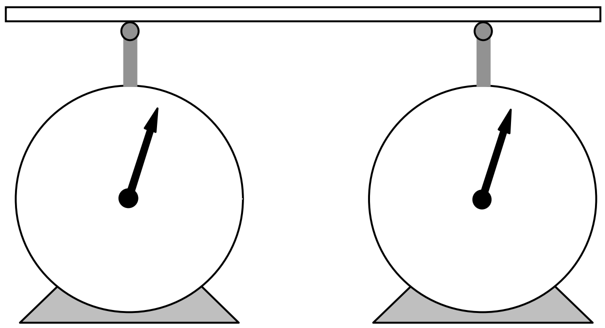
Prediction: If the same person were to stand with each foot on a separate scale what would the support force of each scale read?

Observation: Try this and check your prediction. If your observations don't agree with your prediction, why do you think that is?

What happens if the person on the scale shifts their weight more to one foot than the other?

Revision: Write a simple equation to describe the relationship that you believe exists between the person's weight and the support force of each scale.

Setup: We will now create a more controlled experiment to test your hypothesis. First, use one laboratory scale to weigh the iron mass provided. Unfortunately, the scales are marked in kilograms so you need to multiply by 10 to get the correct weight in Newtons (a unit of force). Remember to zero the scale first by adjusting the nut near the top of the dial. Next arrange two scales to support a board as shown in the diagram. The board is marked and labeled every 10 cm. Position the board so that the scales support it directly below the 20 cm and 100 cm marks. Once the board is in position zero each scale again.



Observation: First, place the center of the mass at the 20 cm mark so that it is directly above one scale. Record the support force reading of each scale in the appropriate box in the table below. Continue to fill in the table by moving the mass to different locations on the board. Be careful not to move the board as you are conducting this experiment.

Position	Left Scale	Right Scale	
20 cm			
40 cm			
60 cm			
80 cm			
100 cm			

Revision: Does your data agree with your predicted equation? Add a column to the table to check your prediction. If your data does not agree with your prediction can you see a pattern that suggests a different equation to describe the relationship between the weight of the object and the support forces of the two scales?

Extension: Can you explain the readings you get if you place the mass at the 10 cm mark?

Lab 1d: Inertia and Mechanical Equilibrium
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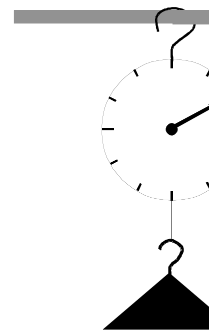
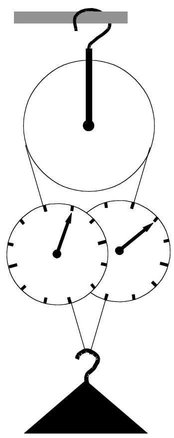


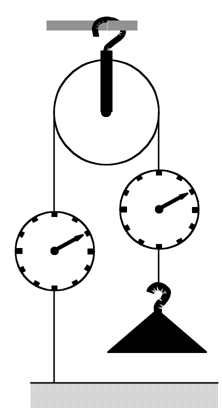
Setup: Hang a mass from a spring scale as shown on the right. The spring scale measures the tension in the spring, which in this case is equal to the weight of the mass. We know this because the mass is in mechanical equilibrium and therefor the force that the spring exerts on the mass must be equal and opposite to the weight which is the force on the mass due to gravity. Record the weight of the mass.

Prediction: If you hang the mass as shown below, with the string looped over a pulley and using two spring scales what will the spring scales read?



Observation: Try this and record your observations.

Revision: How do you account for the different spring scale reading in this configuration?

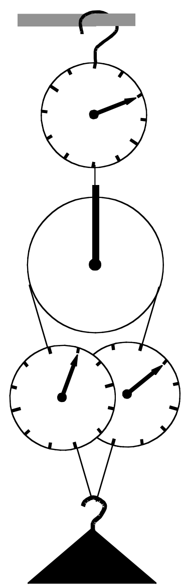


Prediction: If you modify your setup so that only one end of the string is connected to the mass and the other is connected to the table what will the scales read?

Observation: Try it and record your observations.

Revision: Explain your observations in terms of forces and mechanical equilibrium.

Prediction: If the pulley is suspended from an additional spring scale what will this top scale read when both ends of the string are attached to the mass? Also, predict what the top scale will read when one end is attached to the table?



Observation: Try these two configurations and record the results.

Revision: Again, explain your observations in terms of forces and mechanical equilibrium. (Hint: For the second case consider the mechanical equilibrium of the pulley)

Lab 1e: Inertia and Mechanical Equilibrium
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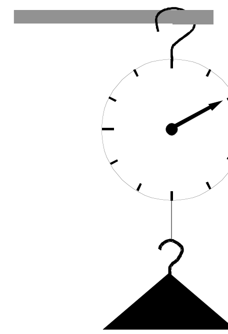


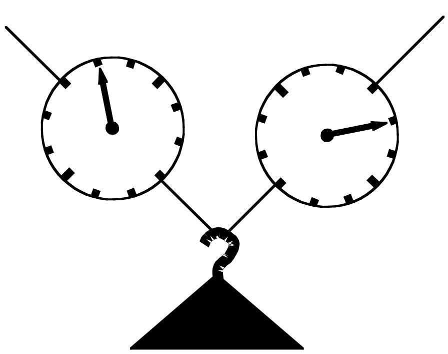
Setup: Hang a mass from a spring scale as shown on the right. The spring scale measures the tension in the spring, which in this case is equal to the weight of the mass. We know this because the mass is in mechanical equilibrium and therefor the force that the spring exerts on the mass must be equal and opposite to the weight which is the force on the mass due to gravity. Record the weight of the mass.

Prediction: If you hang the mass from two spring scales what will each spring scale read?

Observation: Try this and record your observations.

Revision: How do you account for the different spring scale reading in this configuration?

Prediction: How will the readings on the spring scales change if the tops of the spring scales are spread apart as shown so that the strings pull on the mass at an angle?



Observation: Try this for different distances between the tops of the spring scales and record your observations.

Revision: Explain your observations in terms of forces and their directions.
(Hint: Are the strings only pulling up on the mass?)

Prediction: How hard would you have to pull on the strings in order to have them both be perfectly horizontal while supporting the mass?

Observation: Remove the spring scales and try this. Use only one long string and be careful!

Revision: Again, explain your observations in terms of forces and their directions.
(Hint: Can a horizontal string exert a vertical force?)