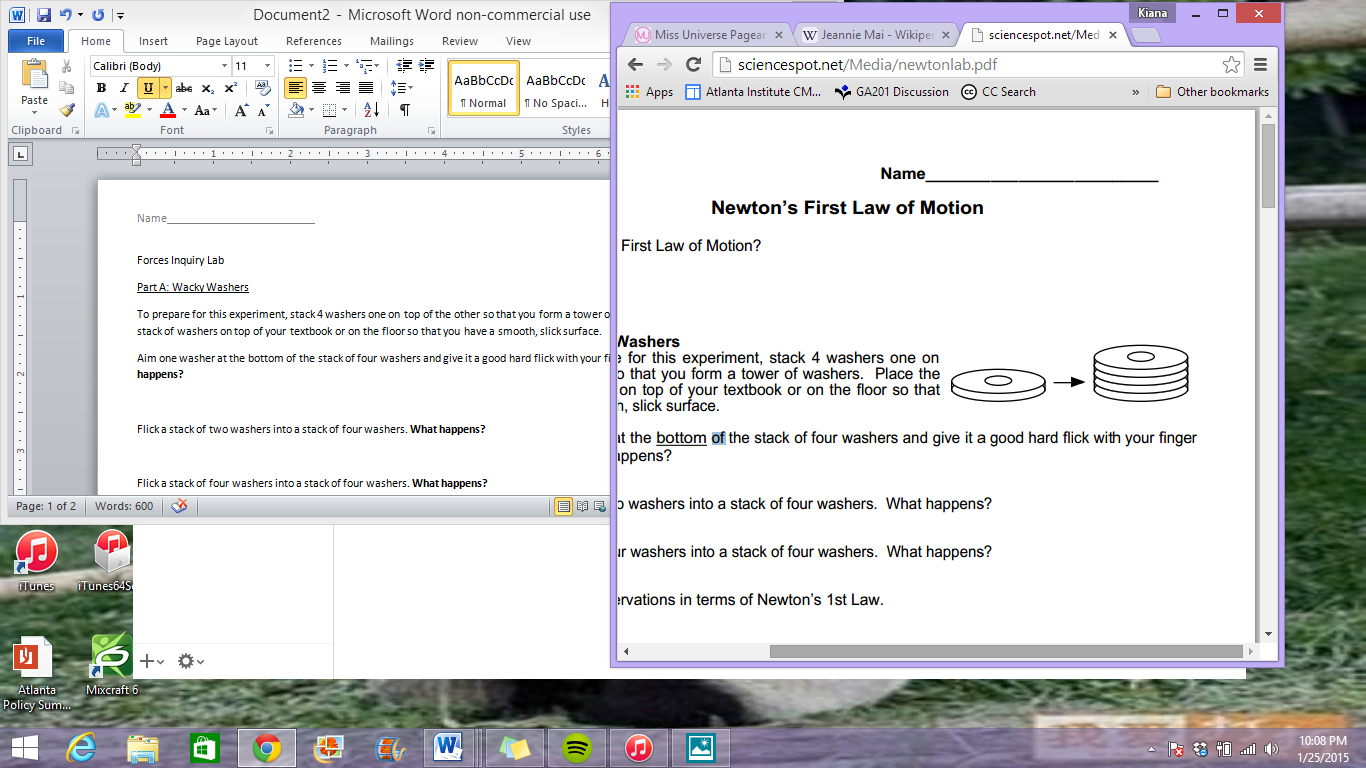
**Forces Inquiry Lab**

Part A: Wacky Washers

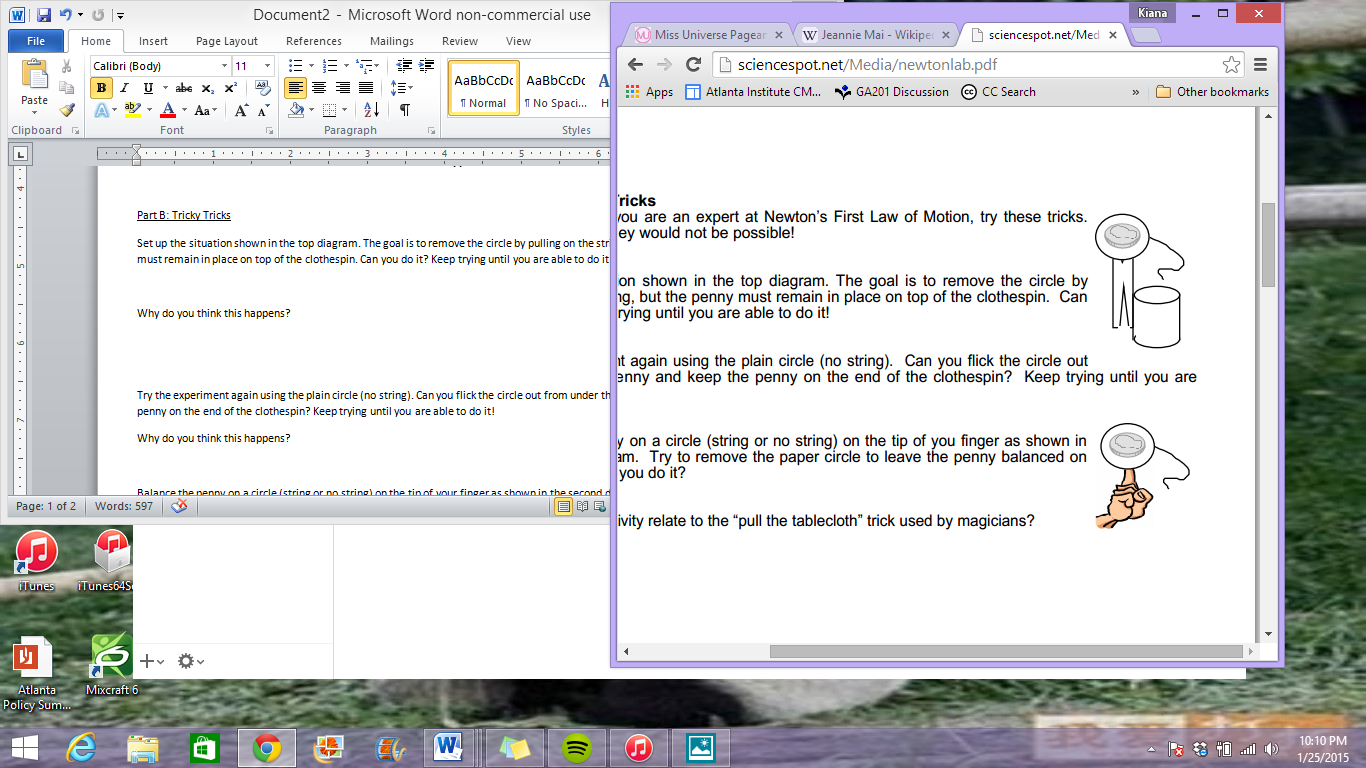
To prepare for this experiment, stack 4 washers one on top of the other so that you form a tower of washers. Place the stack of washers on top of the table so that you have a smooth, slick surface.

Aim one washer at the bottom of the stack of four washers and give it a good hard flick with your finger or hand. **What happens?**

Flick a stack of two washers into a stack of four washers. **What** **happens?**

Flick a stack of four washers into a stack of four washers. **What happens?**

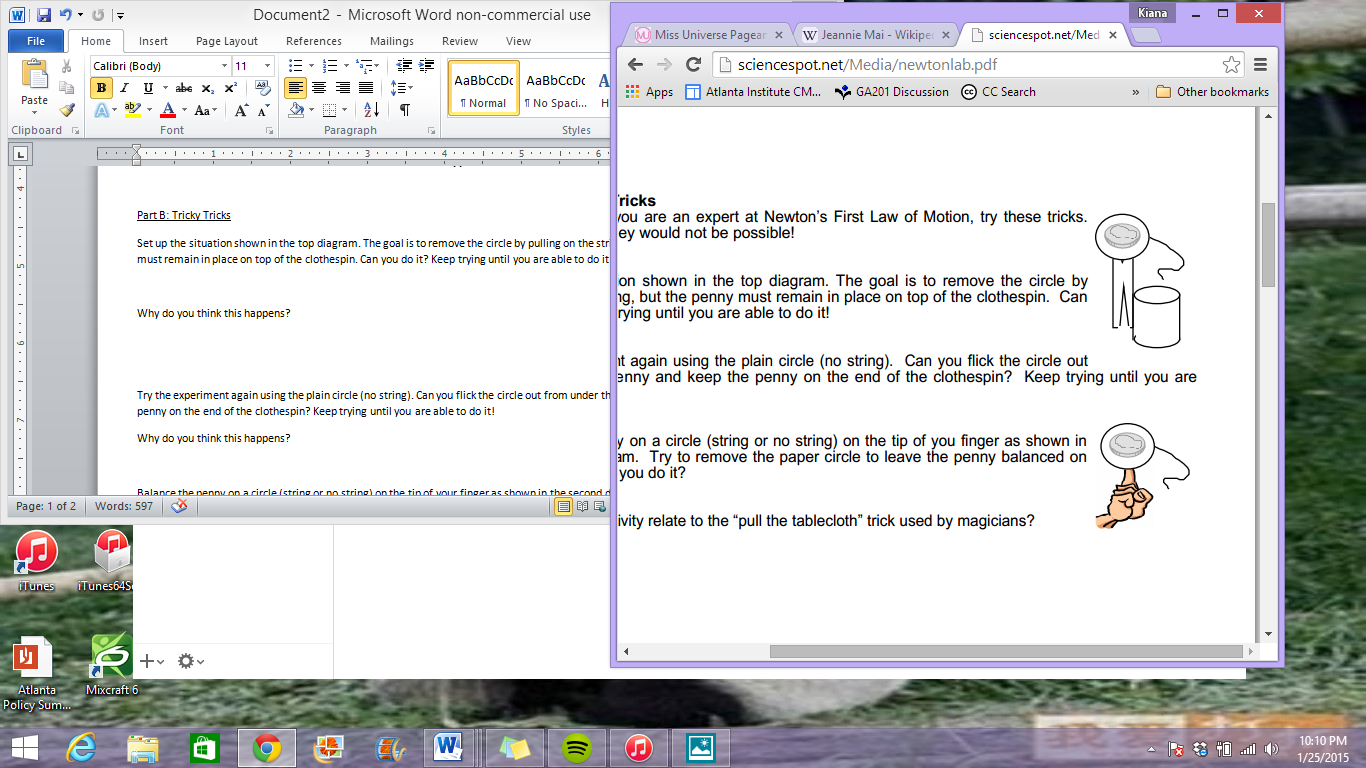
Part B: Tricky Tricks

Set up the situation shown in the top diagram. The goal is to remove the circle by pulling on the string, but the penny must remain in place on top of the clothespin. Can you do it? Keep trying until you are able to do it!

**Why do you think this happens?**

Try the experiment again using the plain circle (no string). Can you flick the circle out from under the penny and keep the penny on the end of the clothespin? Keep trying until you are able to do it!

**Why do you think this happens?**



Balance the penny on a circle (string or no string) on the tip of your finger as shown in the second diagram. Try to remove the paper circle to leave the penny balanced on your finger. Can you do it?

**Why do you think this happens?**

**How does this activity relate to the “pull the tablecloth” trick used by magicians?**

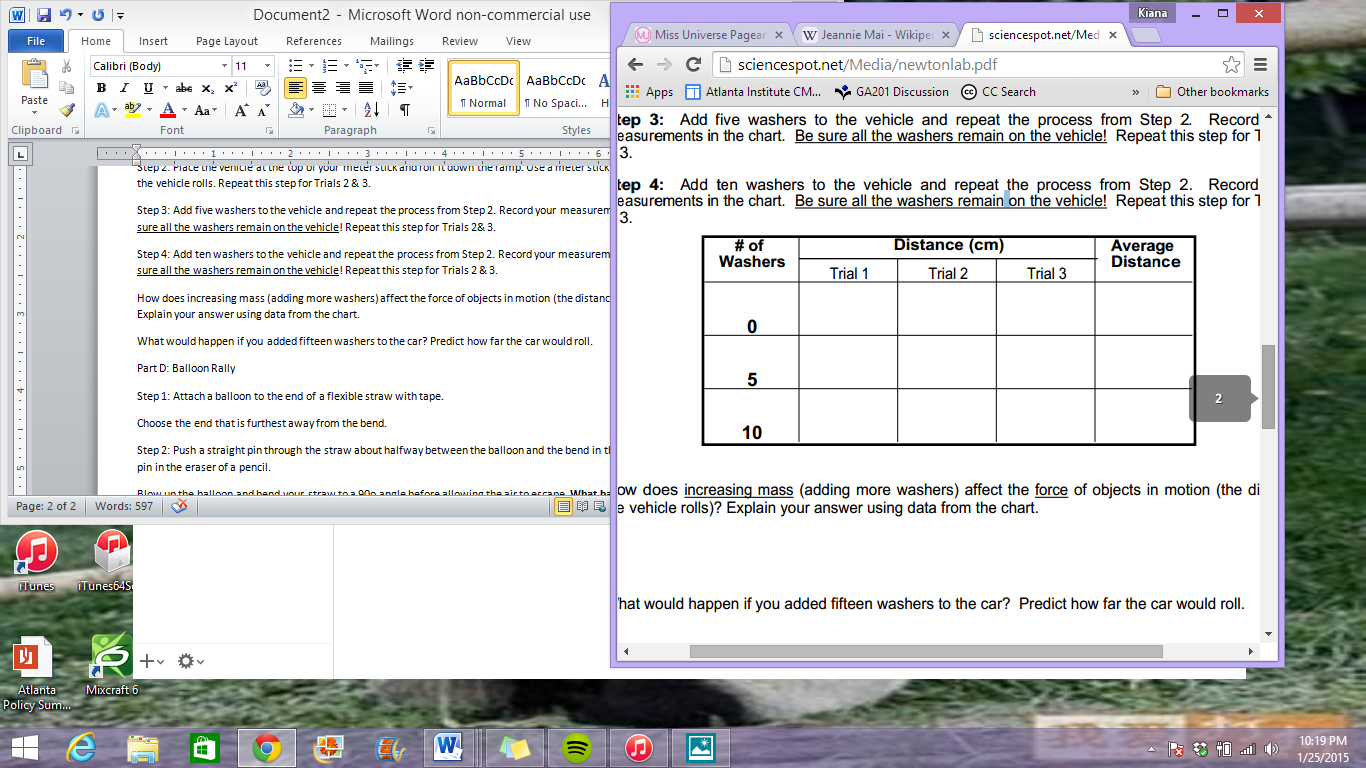
Part C: Newton’s Race

Step 1: Set up a ramp using meter sticks and several books. Place one end of the ramp on the books and line up the other end with a piece of masking tape on the floor.

Step 2: Place the vehicle at the top of your meter stick and roll it down the ramp. Use a meter stick to measure how far the vehicle rolls. Repeat this step for Trials 2 & 3.

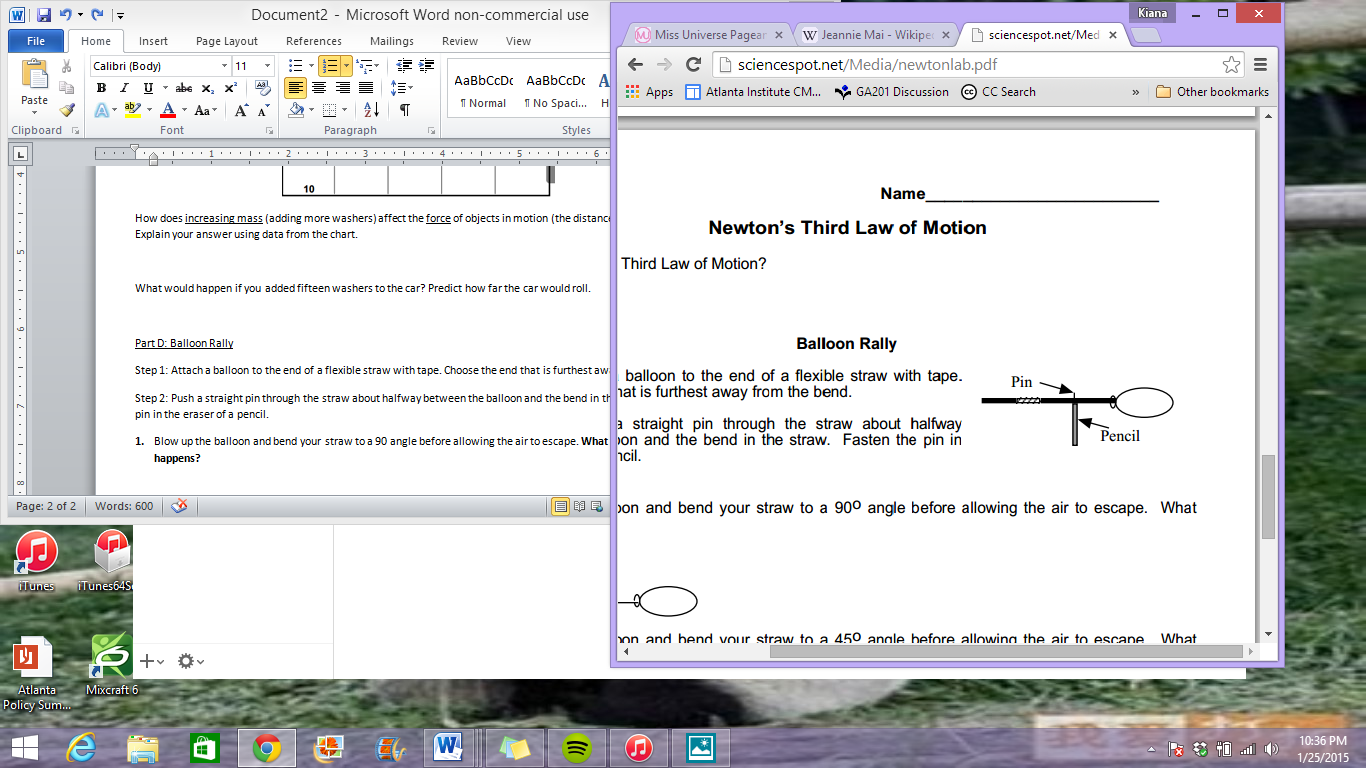
Step 3: Add five washers to the vehicle and repeat the process from Step 2. Record your measurements in the chart. Be sure all the washers remain on the vehicle! Repeat this step for Trials 2& 3.

Step 4: Add ten washers to the vehicle and repeat the process from Step 2. Record your measurements in the chart. Be sure all the washers remain on the vehicle! Repeat this step for Trials 2 & 3.

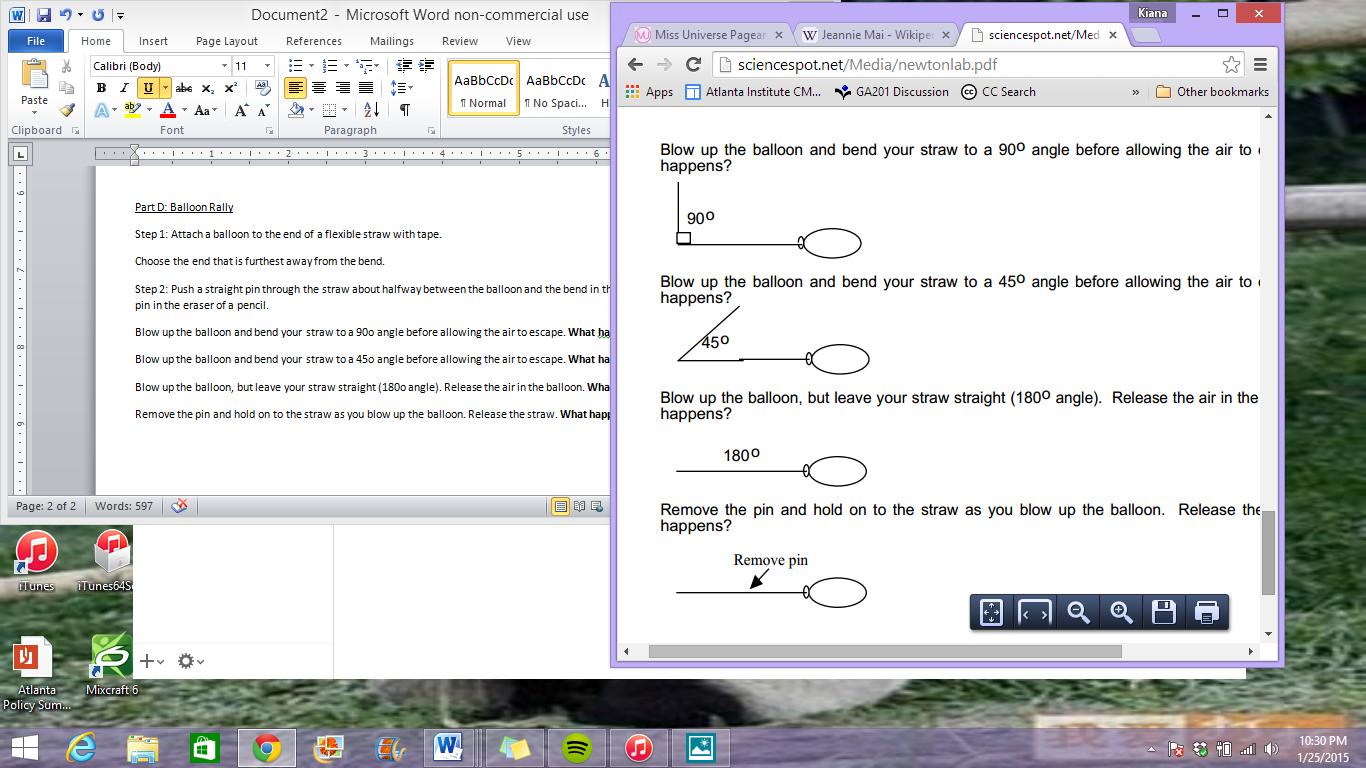
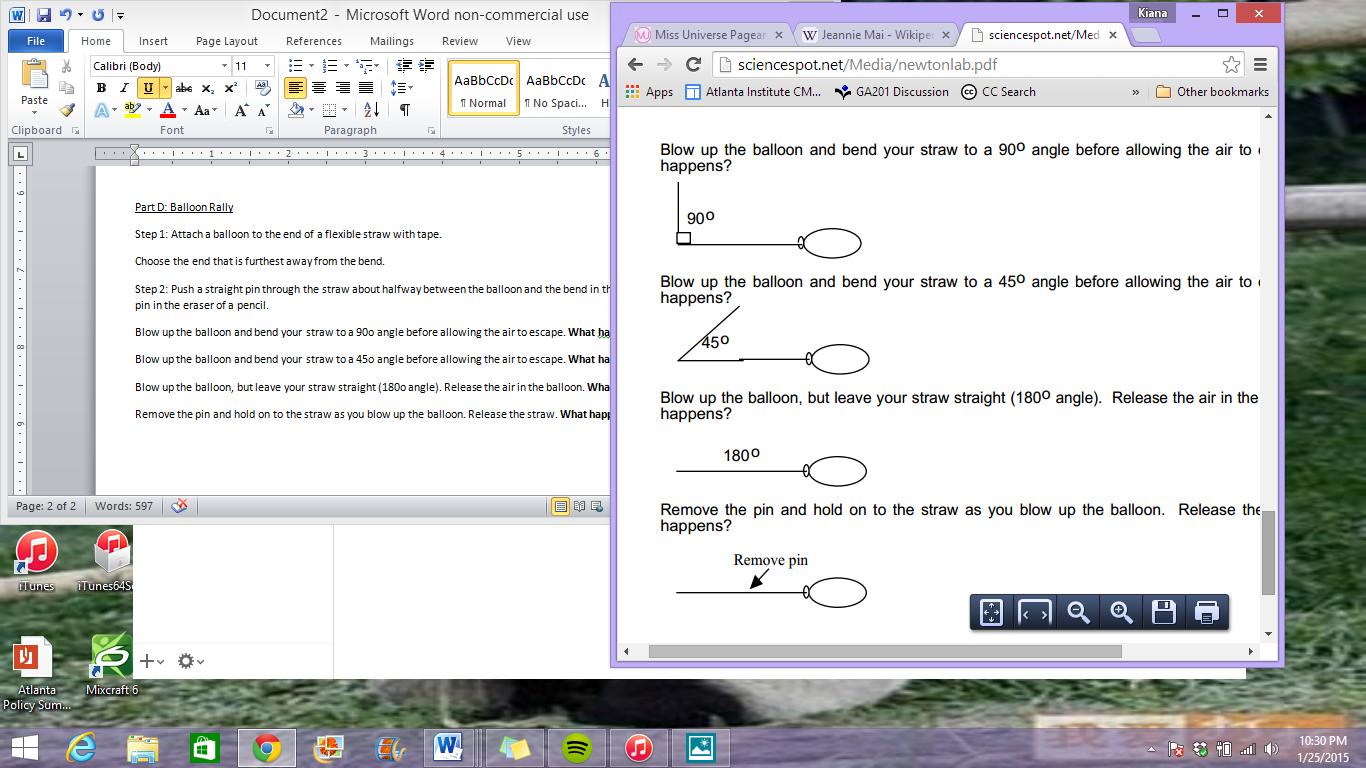
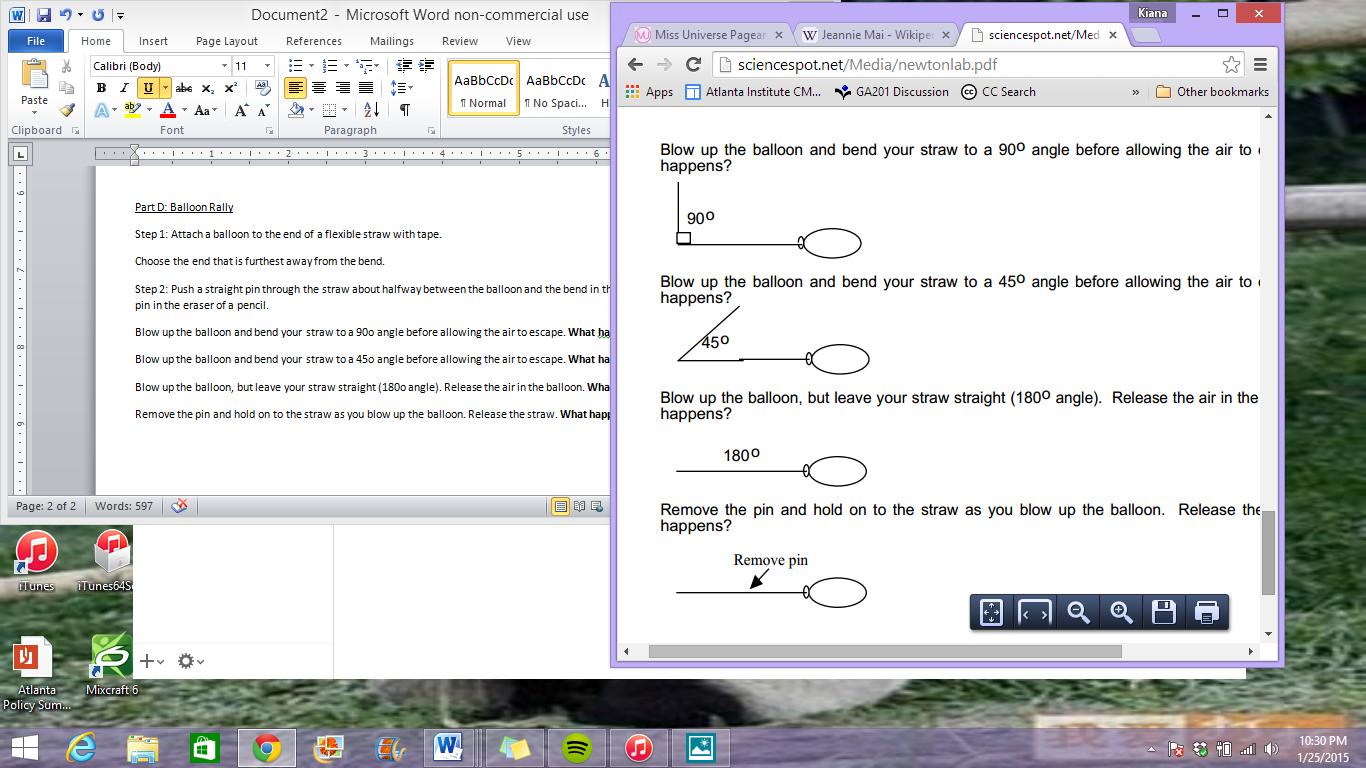
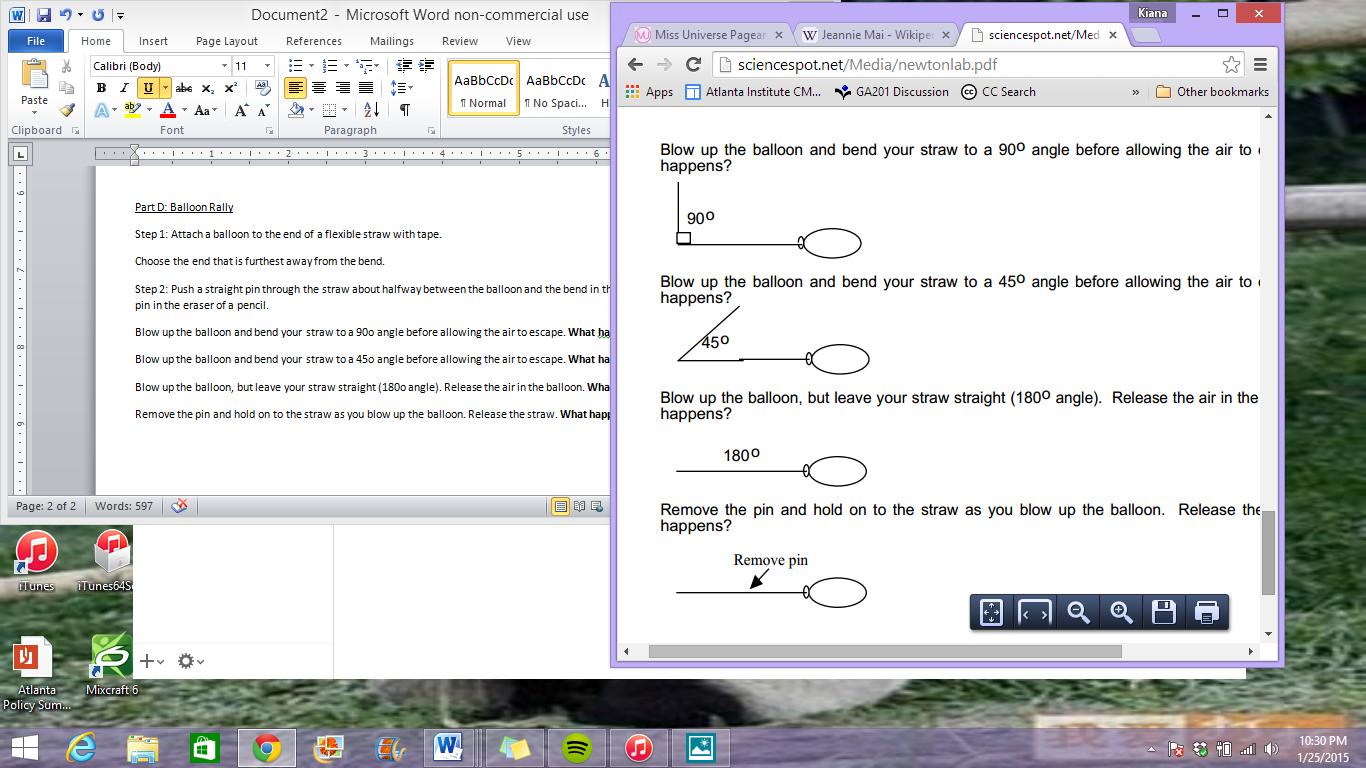


1. How does increasing mass (adding more washers) affect the force of objects in motion (the distance the vehicle rolls)? Explain your answer using data from the chart.
2. What would happen if you added fifteen washers to the car? Predict how far the car would roll.

Part D: Balloon Rally

Step 1: Attach a balloon to the end of a flexible straw with tape. Choose the end that is furthest away from the bend.

Step 2: Push a straight pin through the straw about halfway between the balloon and the bend in the straw. Fasten the pin in the eraser of a pencil.

1. Blow up the balloon and bend your straw to a 90 angle before allowing the air to escape. **What happens?**
2. Blow up the balloon and bend your straw to a 45 angle before allowing the air to escape. **What happens?**
3. Blow up the balloon, but leave your straw straight (180 angle). Release the air in the balloon. **What happens?**
4. Remove the pin and hold on to the straw as you blow up the balloon. Release the straw. **What happens?**

Part E: Push It…Push It Real Good

Push down on the table with your hand.

1. The table feels the downward push of your hand. What do you feel?

2. If there were no friction between your hand and the table, could you still exert this force?

3. In what direction does this force act? (Where is the force coming from and going towards). Draw a diagram of your hand pushing down on the table. Draw ONLY the vector (an arrow) representing the force the table exerts on you (not the force you exert on the table).

4. How would you describe the angle of the force relative to the surface of the table?

5. What would happen to the normal force between you and the ground in the following 2 situations: What would happen to the magnitude of that force if someone were standing on top of you? If you were holding a large bunch of helium balloons?

Part F: Tug-of-War

Hold on to one end of the string while your partner holds the other end. GENTLY pull.

1. Suppose you pull while your partner simply holds. Who feels more of this force, or is it equal for both of you?

2. In what direction does this force act? Draw a diagram of your hand and the string. Then draw a vector (an arrow) showing the force as it acts on your hand (do not show the force your hand exerts on the string).

3. We need to consider the distribution of forces on the string.

a. **Consider** a chain of rubber bands. If the ends of the chain are pulled, which rubber

bands will stretch the most? (Write down the correct answer)

\_\_\_\_\_ The one at the pulled end.

\_\_\_\_\_ The ones near either end of the chain.

\_\_\_\_\_ All the rubber bands in the chain.

b. What does this mean about the whereabouts of this force in the string?

c. Under what condition does this force occur?

d. List one other example of this force?

Part G: Hand Jive

Vigorously rub your hands together.

1. What factors appear to be important for this force? (What makes it bigger or smaller?)

2. List one other situation in which this force occurs.

3. Does this force act at one point or is it spread out somehow? Explain; include a diagram.

4. In what direction does this force seem to act? Draw a diagram of a book sliding across the table, moving to the right. Show the total effect of the force acting on the book by drawing a vector (an arrow).

5. What is the name of this force?

**Part H: Cartoon Physics**

Suppose Wile E. Coyote were to run off a cliff.

1. What force would lead to his demise?

2. What factors appear to be important for this force? (What makes it bigger or smaller?)

3. In what direction does this force act? Draw a diagram of Wile E. Coyote; draw the vector for this force.

4. Does this force act over long distances through space? (Between the Earth and the Sun, for example?

**Part I: Light as feather, stiff as a board**

Hold the feather above the table and drop it.

1. What two forces are operating here?

2. Which force would not be as apparent **if** the coffee filter were wet?

3. In which direction does this force act? Draw a diagram of the falling coffee filter showing the vector (an arrow) for the total effect of this force. Show the vector (another arrow) for the other force you mentioned in number 1, too.

4. Would this force affect a rock falling to the bottom of a pond… A feather falling on the moon?

5. List other situations in which this force occurs or is particularly important?

6. What factors appear to be important for this force? (What makes it bigger or smaller?)