Name: ____________ Date:____________

Dr. Croom's Physics Lab 05-3

Newton's 3rd Law Lab [NOTEBOOK LAB]

Equipment:

2 Pasco Force Sensors, Pasco Interface, Computer, rubber band

Introduction:

The purpose of this experiment is to determine the relationship between forces forming an action-reaction pair. Two Force Sensors are used to measure the paired forces in a rubber band tug-o-war and the paired forces in a collision of two carts.

Theory:

Newton's Third Law states that for every force (the action) there is an equal and opposite force (the reaction).

Setup A: tug-of-war

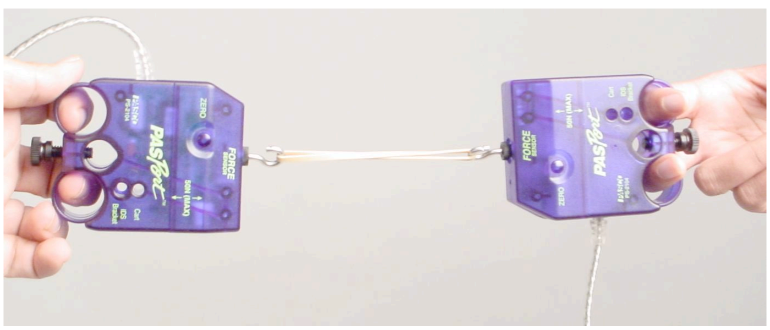

Fig. 1: tug-of-war

1. Connect two Force Sensors to the 1 and 2 analog inputs on your Interface.
2. Attach the hooks to the Force Sensors.
3. With nothing connected to the Force Sensors, press the "ZERO" buttons on the Force Sensors.
4. Attach the hooks of the Force Sensors to the ends of a long rubber band as in the picture above.

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Procedure A: tug-of-war

1. Press the RECORD button at the lower left of the screen.

2. Play a small-scale game of tug-o-war with neither Person A nor Person B winning, but try to vary the force. Do not exceed 50 N.

3. After 10 seconds or so, click STOP.

4. If necessary to delete unwanted data, click the Delete Last Run button at the lower right of the screen.

5. Click open the Data Summary button at the left of the screen. Double click on anyplace that says "Run #1", or whatever the current run is, and re-label it "Nobody wins".

6. Repeat steps 1-5 above with Person A winning, so that Person A moves backward and Person B is "forced" to follow. Label it "A wins".

7. Repeat steps 1-5 above with Person B winning. Label it "B wins".

Analysis A: tug-of-war

1. Click on the black triangle by the Run Select tool on the graph toolbar and select the "Nobody wins" run.
2. Click on the Scale to Fit button on the left of the graph toolbar. The graph should fill the screen. Note that the force is negative because the Force Sensor records a pull as negative and a push as positive.
3. Examine the two curves to see if the forces exerted by person A and person B are the same. You probably have trouble seeing the two sets of data at the same time. Best way is to toggle back and forth between the two data sets. In the box at the middle right, click on the icon under "F,P1" (force at the PASPORT 1 input) to highlight the data in channel 1. Then click on the icon under "F,P2" to highlight that data. Go back an forth and see if you can detect any difference.
4. Now repeat steps 1-3 for the "A wins" and "B wins" data.
5. Are the action/reaction forces equal in magnitude (size)? Even if one person is winning the tug-of-war?
6. Was the force exerted by person A opposite in direction to that exerted by person B? Explain how you know.

<u>Questions</u>

1. If a low mass car (Volkswagon) has a head-on collision with a high mass car (Suburban), which car will experience the larger force?
2. Why do most people get question 1 wrong? (PS, the probability that something like question 1 will be on your next Physics exam approaches 100%.)
3. Did the results of the lab support Newton's 3rd Law?
4. The moon is about 100 times less massive than the Earth. The moon is kept in orbit about the Earth by a force, F, that the Earth's gravity exerts on the moon. What can you saw about the force that the gravity of the moon exerts on the Earth?

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Questions/Things you need to do individually:

Purpose (2pt)

Include

Hypothesis (3pt)

If I pull on your force sensor with my force sensor, how will the recorded forces by each force sensor compare.

Data / Graphs (5pt)

Hand sketch the computer graphs into your notebook.

Results (5pt)

Explain why the graphs look the way the computer generated them.

Questions (8pt)

Answer the questions from the questions section.

Conclusions (2pt)

A normal conclusion.