Name

 Date

 *Newton’s 3rd Law of Motion*

***Station 1- Scooter Forces***

(Equipment: 2 scooters, 2 *willing* participants)

**Predict** what will happen when two students push against each other on smooth, rolling surfaces. \_\_\_\_\_\_\_\_\_\_\_\_

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**Procedure:**

1 Obtain two scooters (we will have to share)

2 Two students will elect themselves to sit on the scooter cross-legged (not touching the ground).

3 The two students should sit facing each other and *less than* arm’s length apart from each other on the scooters.

4 Both students will attempt to push on each other’s hands at the same time. (Identify one Student as A and the other as B.)

5 Draw the two students on scooters, include the forces present

6 Describe the motion of Student A. Describe the motion of Student B. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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7 What force caused the motion of Student A? What force caused the motion of Student B? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Station 2- Penny Slide***

(Equipment: 5 pennies, smooth/slippery surface, and ruler to measure 5 cm)

**Predict** what will happen if 2 pennies collide with a group of 3 pennies. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Procedure:**

1 Obtain 5 pennies

2 Line up 3 pennies touching in a perfectly straight line

3 Line up 2 more pennies touching each other in a perfect line with the three other pennies. There should be a 5 cm gap between the groups of pennies. (See below)

4 Place your fingers onto the two slider pennies. Slide the pennies into the group of 3 pennies. Be sure that the two slider pennies stay in contact with each other when they collide with the group of 3. (This may take practice to slide them correctly.)

5 Record what happens to the group of three pennies after the collision. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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6 Repeat the collision several more times with different combinations of sliders (do not reuse 2 pennies).

7 Draw what combination you experimented with and include all of the forces interacting with each other.

8 Record what happens to your new combination of pennies after the collision. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Station 3- Visualizing Inanimate Forces***

(Equipment: meter stick, 6 books, coin, 300 g worth of mass, and a ruler)

**Predict** what will happen when you place weights on a meter stick held up on each end by books. \_\_\_\_\_\_\_\_\_\_\_\_

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**Procedure:**

1 Set up a meter stick with a few books for support under each side of the meter stick.

2 Place a coin in the center of the meter stick.

 Record what happens. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

 Measure and record the height of the meter stick. \_\_\_\_\_\_\_\_\_ cm

3 Remove the coin and replace it with a 100 g mass (100 g mass= 1 N).

 (\*Deflection is the difference from the original height to the new “bent” height.)

 Measure and record the deflection of the meter stick. \_\_\_\_\_\_\_\_\_ cm

4 Now make your mass 200 g (200 g mass= 2 N).

 Measure and record the deflection of the meter stick. \_\_\_\_\_\_\_\_\_\_ cm

5 Now make your mass 300 g (300 g mass= 3 N).

 Measure and record the deflection of the meter stick. \_\_\_\_\_\_\_\_\_\_ cm

6 How does the deflection of the meter stick compare to the weight it is supporting? Are any relationships present?

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7 Draw the setup with a mass of any size on the meter stick and identify all of the forces.

8 When you sit on a chair, the seat of the chair pushes up on your body with a force equal and opposite to your weight. How does the chair “know” exactly how hard to push up on you? Is there any “deflection” going on? \_\_\_

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***Station 4- Unequal Forces***

(Equipment: two spring scales, two gentle participants)

**Procedure:**

1 Clip two spring scales together.

2 Each one of you will pull GENTLY on one scale. Try to pull so that one of you pulls with twice the force of the other. (Do not pull on the scales so hard that they read a measurement above the highest value.)

\*You will have applied unequal forces if you can make one scale read twice the value of the other scale.

3 Draw the experiment setup (two hands, two spring scales with readings) and include all of the forces applicable.

4 DO NOT DO THIS, but hypothesize what would happen if one person releases their pull on the spring scale. Explain how the forces change. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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5 Compare the amount of force experienced by each football player when a big linebacker tackles a small running back player. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Station 5- Balloon Rocket***

(Equipment: fishing line, straw, tape, balloon)

**Predict** what will happen when you release air out of a balloon. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Procedure:**

1 The fishing line and straw are already connected to inanimate objects in the room.

2 One person will have to hold the loose end of the fishing line straight and at the same height as to what it is attached at.

3 Blow up the balloon. DO NOT TIE IT CLOSED. Pinch the balloon closed while another team member gently tapes the middle of the balloon to the straw.

4 Release the balloon. (The balloon, which is attached to the straw, should move down the fishing line.)

5 Draw a free-body/force diagram of the forces acting on the ENTIRE activity.

5 Explain how this activity demonstrates Newton’s Third Law of Motion. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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6 Pretend you redid the activity. How would more air in the balloon affect the path of motion? What do you think would happen if the balloon reached the end of the string? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***Extended thinking***

1 Look at the triple beam balance (we used in Chemistry class). Explain how this balance demonstrates Newton’s Third Law. (You can draw the diagram with all of the forces OR write an explanation.)

2 Use Newton’s Third Law to explain why baseball players prefer to wear gloves for catching high-speed balls. Use a pair of forces in your explanation. (You can draw the diagram with all of the forces OR write an explanation.)