**Marble Collisions**

**Introduction:**  
When Robin Hood fired his bow & arrow, he probably had a good understanding of the science behind it. Tension in the bow would push the arrow forward, causing it to accelerate and fly through the air. On the way to its target, it would drop slightly and also be slowed by air resistance. What Robin Hood probably did not understand was that, in addition to the bow pushing the arrow forward, the arrow also pushed the bow backward. The bow, plus Robin’s arms, plus his body, plus the entire planet Earth would be pushed backward with the same force that sent the arrow forward. Of course, because of the large mass of his body – *not to mention the mass of planet Earth!* – the resulting acceleration was hard to notice. In fact, it went unnoticed for thousands of years. Then came Sir Isaac Newton. According to Newton’s Third Law of Motion, “For every action there is an equal and opposite reaction.”

**Procedure:**

1. Lay two meter sticks across your table, with the centimeter side facing up.
2. Make sure the gap between the meter sticks is just barely wider than one of your marbles.
3. Place your clipboard, which will act like a ramp, next to one end of the meter sticks.
4. Mark a spot, halfway up your clipboard, with a pen or pencil. This will serve as your “lower drop point.”
5. Mark a spot at the very top of your clipboard. This will serve as your “upper drop point.”
6. Complete each of the tests in the data table below. Record your observations.

**Results:**

| **Instructions** | **Action** | **Reaction** | **Equal and Opposite?** |
| --- | --- | --- | --- |
| *Set one marble halfway down the track (at 50 cm). Drop another marble from the lower drop point. Watch the marbles collide.* | **When the marble drops down it has a lot of force and action to push the other marble.** | **When the marble collided with the other marble it barely moved the other marble because it had not a lot of force.** | **Both marbles started moving but the opposite force slowed the first marble.**  **Opposite** |
| *Set one marble halfway down the track (at 50 cm). Drop another marble from the upper drop point. Watch the marbles collide.* | **When the marble dropped at the upper point it had more speed to bump into the other marble.** | **When the marble collided with the other marble it made it go farther than the first time we did the first experiment.** | **When the first marble came in contact with the other one it slowed the first marble (opposite force). But it made the other marble go faster.** |
| *Set two marbles, side-by-side and touching, halfway down the track (at 50 cm). Drop a marble from the lower drop point. Watch the marbles collide.* | **When the Marble rolled down, it made an impact, and slowed to a halt.** | **The middle marble was stationary. Last marble was impacted, sped up, and rolled away** | **It was opposite, not equal.** |
| *Set two marbles, side-by-side and touching, halfway down the track (at 50 cm). Drop a marble from the upper drop point. Watch the marbles collide.* | **When the two marble were hit by the marble rolling down it didn’t move the marble very far.** | **The middle marble only moved a little bit and the last marble moved very far.** | **It was opposite** |
| *Set three marbles, side-by-side and touching, halfway down the track (at 50 cm). Drop a marble from the lower drop point. Watch the marbles collide.* | **When the first marble came down it made the middle marble push the other marble which pushed the last marble andmade go not very far.** | **The middle marble moved fast, the third marble made the fourth marble move a little bit.** | **It was equal and opposite** |
| *Set three marbles, side-by-side and touching, halfway down the track (at 50 cm). Drop a marble from the upper drop point. Watch the marbles collide.* | **When the first marble came down it made the second marble a lot, the third marble a little and the fourth marble made it move a lot.** | **The middle marble went very fast, the third marble slowed down and the fourth marble sped up.** | **It was equal and opposite.** |
| *Set four marbles, side-by-side and touching, halfway down the track (at 50 cm). Drop a marble from the lower drop point. Watch the marbles collide.* | **When the first marble came down it knocked the second marble into the third marble very fastly then the fourth marble going slower and finally knocking in the fifth marble making it barely going any far.** | **The middle marble made it go very fast made, the third marble go slower, the fourth marble even slower and the fifth marble the slowest.** | **It was equal and opposite.** |
| *Set four marbles, side-by-side and touching, halfway down the track (at 50 cm). Drop a marble from the upper drop point. Watch the marbles collide.* |  |  |  |

**Post-Lab Conclusions:**

1. What is Newton’s First Law of Motion? Newton's First law of motion states that, if a body is at rest or moving at a constant speed in a straight line, it will remain at rest or keep moving in a straight line at constant speed unless it is acted upon by a force.
2. What is Newton’s Second Law of Motion? Newton's Second law of motion states that acceleration is produced when a force acts on a mass. The greater the mass of the object to be accelerated the greater the amount of force needed to accelerate the object.
3. What is Newton’s Third Law of Motion? Newton's Third law is that for every force in nature there is an equal and opposite reaction.
4. In today’s lab, which of the trials contained an “equal and opposite” reaction? The third marble experiment and the fourth one.
5. Explain how, even though the marbles were always rolling in the same direction, the actions/reactions were still equal and opposite forces. It is because for every action force there is a reaction force. After the collisions, why wasn’t the last marble rolling quite as fast as the first marble? It is because the more marbles it hits, the slower the impact makes the marble slower.
6. Explain how today’s lab actually displayed all three of Newton’s Laws.
   1. When you drop the marble into the other marble it begins moving, when you are exerting a force on it demonstrates Newton's 1st Law of motion
   2. When your marble has little mass and doesn't require a lot of force to start moving it through the ruler it hits the marbles causing them to hit into other marbles that demonstrates Newton's 2nd law of motion.
   3. When the marble hits the walls of your rulers, it bounces off the walls it demonstrates Newton's 3rd law of motion.