Discovering Newton’s Laws

Purpose:
• To explore the factors that cause a change in motion of an object
• To determine the effect of mass on an object’s acceleration
• To investigate the acceleration of two objects acting on one another.

Part 1: An object at rest

• Carefully fill the beaker about half full with water. Wipe the lips and the outside of the beaker with a paper towel
• Place an index card on top of the beaker so that the card covers the opening of the beaker. Place the coin on top of the card
• Remove the index card by pulling it away quickly. Make sure you pull the card perfectly horizontally.

Part 1: Analysis and Questions

1. What happened to the coin when the card was pulled out from underneath? (1 pt)

2. Is this what you expected to happen? Explain why or why not. (2 pts)

3. What would happen to the coin if the card was pulled out very slowly? Try it and compare your results (2 pts)
Part 2: An object in motion

- Make sure there are no obstacles or obstructing traffic in between the start line and the wall.
- Place the toy or doll on the cart and place the cart about 1.0 meter away from the wall. Push the cart and toy forward so that they run into the wall.
- Place the cart at the same starting place, about 1.0 meter away from the wall. Return the doll to the cart, and use a rubber band to hold the doll securely in the cart.
- Push the cart and doll forward so that they run into the wall. Observe what happens to the doll when the cart hits the wall.
- When you are finished, separate the doll, cart and rubber band and return them to the table. Do not leave the cart on the floor.

Part 2: Analysis and Questions

1. What happened to the unsecured doll when the cart hit the wall? (1 pt)

2. What happened to the doll secured with the rubber band when the cart hit the wall? (1 pt)

3. How did the rubber band change the result of the experiment? Explain why this happened. (2 pts)

4. Compare the experiment with the doll and cart with the experiment with the card and coin. Explain how the results of the two are similar. (2 pts)
Part 3: Newton’s Second Law

- Place the car at one end of the table. Ensure the pulley is tightly clamped to the table.
- Thread the cord over the pulley wheel at the end of the table. The car should be held securely in place at the opposite end of the track. Attach a mass to other end of the cord.
- Make sure the mass will be able to fall about 1 m without hitting any obstacles. **Watch out for feet and toes!**
- Be ready to catch the car before it reaches the end of the table.
- While the car is moving, make careful observations. Try to determine whether the car moves with constant velocity or whether it accelerates.

- Replace the mass with another one and repeat the above steps. Carefully observe the motion of the car.
- Repeat several times using different masses. Do not exceed 300 grams. As you change the mass, watch the motion of the car for observable patterns. (5 pts)

<table>
<thead>
<tr>
<th>Weight (g)</th>
<th>Observations – Be descriptive – use words like minor, major, extreme, small, large, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
</tr>
<tr>
<td>250</td>
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</tbody>
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Part 3: Analysis and Questions

1. What caused the car to start moving? (1 pt)

2. Did the car move with a constant velocity or was it accelerating? Explain. (2 pts)

3. How did the magnitude of the falling mass affect the motion of the car? Explain. (2 pts)
Part 4: Newton’s Third Law

- Place the carts in the middle of the track.
- Compress the spring mechanism and place the carts so that they are touching, as shown.
- Quickly release the spring and observe the two carts. Do not allow the carts to fall off the track.
- Return the carts to their original position and compress the spring. Add two mass bars to one cart. Release the spring and observe the two carts.
- Return the carts to their original position and compress the spring. Add two more mass bars to the heavier cart. Release the spring and observe the carts.

Part 4: Analysis and Questions

1. What happened to the two carts when the spring was released? (1 pt)

2. Fill in the chart with your observations about the motion of the carts in terms of its acceleration from rest. (6 pts)

<table>
<thead>
<tr>
<th>Mass</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
</tr>
<tr>
<td>2 bars (500 g)</td>
<td></td>
</tr>
<tr>
<td>4 bars (1000 g)</td>
<td></td>
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</tbody>
</table>

3. What is the relationship between the mass of a cart and its acceleration when the spring is released? (2 pts)