Physics

Newton's 2nd Law – Playing with Acceleration

Name:____ Block:__________

We have already explored Newton's 1st (inertia) and 3rd (action/reaction) Laws. Today you will be exploring Newton's 2nd Law of Motion. According to Newton's 2nd Law force, mass, and acceleration are related; you will explore that relationship. First we will look at how force affects acceleration and then we will consider how mass affects acceleration.

Materials

- Balloon
- Tape
- Straw
- Long String
- Short String
- Clothespin
- Stop Watch
- Meter Stick
- Washers

Procedure

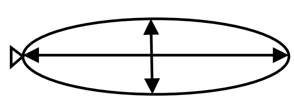
Part 1: Force and Acceleration

1. Define force.

2. Using a balloon, how can you manipulate the amount of force?

3. Define acceleration. What is the formula you have already learned to calculate acceleration?

4. Tape one end of the long string to the wall and have a group member hold the other end. Do not pull on the string; it needs to be taut but still connected to the wall.
5. Blow up your balloon and pinch the mouth closed by twisting and then clothes-pinning the neck of the balloon. Use the short string and meter stick to measure the circumference of the balloon (in meters) and record this data in Table 1. You will need to measure around the balloon short and long directions, then average these two measurements (see diagram).



6. Thread the straw onto the long string. (Remember, you still have the balloon pinched closed.)
7. Tape the balloon to your straw so the mouth of the balloon points away from the wall.
8. Measure the time and displacement of the balloon as it travels along the string.
    a. Have your timekeeper announce when to release the balloon. Stop the timer when the balloon stops and record time in Table 1.
    b. When the balloon stops, clip the clothespin to the string DIRECTLY BEHIND the straw.
    c. Measure from the hand of the person holding the string to the clothespin and record the distance traveled in Table 1.
9. Repeat steps 5-8 twice more, blowing your balloon up to different circumferences.

10. Use the data to calculate the balloon's acceleration during each trial: $a = \frac{2\Delta x}{t^2}$
    where a=acceleration, Δx=displacement, and t=time.
11. Graph the acceleration (dependent) vs. circumference (independent).
12. Based on your data, write a statement that compares force (related to the circumference of the balloon) with the acceleration.

Table 1

	Circumference (m)					
Trial	Long	Short	Avg.	Displacement (m)	Time (s)	Acceleration (m/s^2)
1						
2						
3						

Graph 1: Acceleration vs. Circumference

Remember:
- If you measured in cm, you need to convert to meters – in other words, move the decimal two places to the left.
    - For example:
      50.5 cm = .505 m
- The independent variable is always graphed on the x-axis.

Part 2: Mass and Acceleration

1. Define mass.

2. Based on the materials given, how can you change the mass?

3. Using the same setup as in Part 1, prep your balloon "rocket" for your first trial. NOTE: It is VERY important that you blow your balloon up to the same size for each trial (approximately the length of a sheet of paper)!
4. Have your timekeeper announce when to release the balloon. You need to measure the time and distance the balloon travels along the string – just like you did in Part 1. Record this data in Table 2.
5. Use the electronic balance to determine the mass of your system (balloon, straw, tape, etc.) and record it in Table 2.
6. Add mass to the system by adding one washer to the FRONT end of the straw. Make sure it is secure and will not fall off.
7. Repeat steps 4-5.
8. Add additional mass to the system by adding another washer to the FRONT end of the straw. Make sure they are secure and will not fall off.
9. Repeat steps 4-5.
10. Use the data to calculate the balloon's acceleration during each trial: $a = \frac{2\Delta x}{t^2}$
    where a=acceleration, Δx=displacement, and t=time.
11. Graph the acceleration (dependent) vs. mass (independent).
12. Based on your data, write a statement that compares mass with the acceleration.

Table 2

Trial	Mass (g)	Displacement (m)	Time (s)	Acceleration(m/s^2)
1				
2				
3				

Graph 2: Acceleration vs. Mass

<u>Questions</u>

1. Describe the trend in Graph 1.

2. Describe the trend in Graph 2.

3. What are Sir Isaac's three Laws of Motion? (look them up online if needed)
   a.

   b.

   c.

4. Using Newton's 2nd Law, calculate the net force (ΣF) on the system for each trial in Part 2.