Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_ Date \_\_\_\_\_\_\_\_\_\_ \_\_\_\_ Period \_\_\_\_\_\_\_

**Under Pressure**

**Background**: A rocket's movement depends on Newton's 3 Laws of Motion

**Objective**: To have a balloon travel over a measured distance in the shortest possible time. The balloon will be attached to a soda straw. The soda straw will have a length of string running through it. The bottle will then travel along a length of fishing line or thread after being filled with air, and the air inside then being allowed to escape.

**Problem:**

**Hypothesis** :

**Materials:**

1. 6 feet (1.8 m) of string (cotton, fishing)
2. 4-inch (10 cm) piece of drinking straw (can vary the size)
3. 2 chairs
4. 9-inch (23 cm) round balloon
5. Transparent tape

**Procedure**:

1. Using the materials available, design and construct a balloon rocket.
2. Predict which design will have the greatest velocity. (Make a prediction about balloon type, string type or length of straw)
3. Blow up the balloon and pinch the ends with your fingers. Do not tie it!
4. Measure the circumference of the round balloon by placing a string or measuring table around the largest part of the balloon. Measure the length of the airship balloon. (This must be kept constant for the three trials)
5. Thread the string through the drinking straw. Tape the long side of the balloon along the length of the straw.
6. Have two people hold the ends of the string. Make sure the string is stretched tight. Or attach both ends of the string to a chair about 4 feet (1.2 m) off the floor.
7. Slide the balloon-straw system down the string until the clamped end reaches the end of the string held by a person or attached to a chair.
8. Release the balloon. Record the time for the balloon to get to the end of the string.
9. Measure how far the balloon traveled and record that distance.
10. Record your observations. Complete at least 3 trials and record.
11. Calculate average distance traveled, time and average speeds for each test in the table below.
12. Construct a distance-time graph for the average data (distance on the y-axis, time on the x-axis).
13. Draw a best fit line and calculate the slope of the line.
14. Construct a velocity-time graph for the average data (velocity on the y-axis, time on the x-axis).
15. Draw a best fit line and calculate the slope of the line.
16. Answer the analysis questions after you have completed the data table.

**Round Balloon Filled All the Way With Air (Circumference = )**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trials** | **Distance Traveled (cm)** | **Time (s)** | **Average Speed (cm/s)** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| Average |  |  |  |
|  |  |  |  |

**Round Balloon Filled Halfway With Air (Circumference = )**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trials** | **Distance Traveled (cm)** | **Time (s)** | **Average Speed (cm/s)** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| Average |  |  |  |
|  |  |  |  |

**Balloon With Long Straw (Length of Straw = )**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trials** | **Distance Traveled (cm)** | **Time (s)** | **Average Speed (cm/s)** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| Average |  |  |  |
|  |  |  |  |

**Balloon With Short Straw(cut your straw in half) (Length of Straw = )**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trials** | **Distance Traveled (cm)** | **Time (s)** | **Average Speed (cm/s)** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| Average |  |  |  |
|  |  |  |  |

**Calculations**

Velocity = distance

Time

Acceleration = Vf - Vi

Total time

**Analysis**

1. What is the action force in this activity? What is the reaction force?
2. Draw and label a diagram of all the forces acting on the balloon.
3. How does your prediction compare with your results?
4. What happened when the amount of force was changed?
5. Explain your findings using Newton’s 2nd Law of Motion.
6. Explain the motion of the balloon using Newton’s 3rd Law of Motion.
7. What do you think will happen if you increased the mass on the balloon? Use Newton’s 1st and 2nd Law of Motion to answer.
8. What does the slope of a position-time graph represent?
9. How does the calculated average velocity compare with the calculated slope?
10. What does the slope of a velocity-time graph represent?

**Answer Key**

**Analysis**

1. What is the action force in this activity? What is the reaction force?

**Action Force is the force of the air pushing the balloon away as it escapes. Reaction force is the force with which the balloon pushes back on the air, causing the balloon to move in the opposite direction of the escaping air.**

1. Draw and label a diagram of all the forces acting on the balloon.

straw

string

thrust drag

gravity

1. How does your prediction compare with your results?

**Answers will vary.**

1. What happened when the amount of force was changed?

**When you blow up the balloon, you increase the amount of air pressure (force per area) in the balloon, which increases the amount of force the air pushes back on the balloon with as it escapes. When you release the balloon, air from inside the balloon escapes. The more the balloon is inflated, the greater the pressure of the air inside the balloon, and the greater the force with which the air pushes on the balloon as it escapes.**

1. Explain your findings using Newton’s 3rd Law of Motion.

**When you release the balloon, the balloon pushes back in the opposite direction of the escaping air,resulting in the thrust that thrust propels the balloon rocket forward.**

1. What do you think will happen if you increased the mass on the balloon? Use Newton’s 1st and 2nd Law of Motion to answer.

**According to Newton’s 1st Law, an object at rest or in motion will remain at rest or in motion until an unbalanced force acts upon it. Inertia, tendency to resist change in motion increases as mass increases. Therefore, increased mass will increase inertia, resulting in a smaller acceleration of the balloon.**

**According to Newton’s 2nd Law, F=ma; m=F/a; a= F/m, therefore if you increase mass and while force remains constant, the acceleration will decrease.**

1. What does the slope of a position-time graph represent?

**Velocity**

1. How does the calculated average velocity compare with the calculated slope?

**Should be similar/same**

1. What does the slope of a velocity-time graph represent?

**Acceleration**