Investigative Question

How does the size of a parachute affect its landing time?

Introduction:

As a class we discussed parachutes and the factors that affect landing times. We voted and decided that the size of a parachute would be a really fun independent variable to test. The three sizes that we decided to test are: 7cm, 14 cm and 21 cm in diameter. We will be controlling all of the variables by using the same weight, the same height of the drop, the same environmental conditions and the same materials.
Parachutes are used for many things. They are used by race cars, space shuttles, aircraft and skydivers to help them slow down to a safe speed. The parachute slows the speeding body down because it causes air resistance, or drag. Drag is the friction between an object and the air that it is moving through. The larger an object is, the bigger the surface area it will have. This larger surface area causes more air molecules to be moved aside which leads to more drag. The more drag, the slower the speed of descent. The air causing this drag pushes the parachute back up, and creates a force opposite to the force of gravity or any force that is moving forward. As a skydiver falls slowly to the earth with a parachute, these "push and pull" forces are nearly in balance. The drag force from the parachute is slightly less than the force of gravity, so the skydiver floats slowly to the ground.

Sir Isaac Newton described several Laws of Motion. His First Law of Motion states that if the forces on an object are in balance, the object's speed and direction of motion won't
change. Therefore if an object is not moving, it will continue to stay still and if it is moving, it will continue to move in a straight line at a constant speed. Skydivers go through periods of time on every jump where the forces are not balanced therefore they are often accelerating. It is known that the force of gravity is pulling all objects towards the earth at an acceleration rate of 9.8m/s$^2$. In freefall (without the parachute out) the force of gravity is greater than the drag on the body so it accelerates. The faster an object moves through air, the greater the drag. This means that as the skydiver accelerates the amount of drag increases. Eventually, the drag will be equal to the force of gravity which means that the person will no longer be accelerating, but moving at a constant speed just as Newton described. This is called terminal velocity, and is roughly 125 miles per hour. Without a parachute to help balance the forces, a person will hit the ground at 125 miles per hour! Once a parachute has been deployed, the skydiver’s surface area is increased. This leads to increased drag and a rebalancing between drag and gravity. This balancing of the forces leads to
a new constant velocity of 14 mph which is a much safer rate of
descent. Parachute design must take several things into
consideration. The canopy’s stability relies on allowing air to
escape smoothly. Creating a vent at the apex of the parachute
that is between 1 and 10% of its flat surface area will allow air
to exit smoothly rather than on alternating sides. Suspension
lines will reduce the parachute’s surface area because they pull
the canopy in and down. Lengthening the lines can decrease
the descent speed. Real parachutes are made of a lightweight,
reinforced nylon, much like tent material and are very
durable.

Area of a circle: Circle Area  =  \pi \cdot \text{radius}^2

Rectangle (or square): Area = \text{Length} \times \text{Width}

Area of a Triangle: \frac{1}{2} \text{ of the base} \times \text{the height}
Hypothesis:
I predict that the____cm parachute will ______________
__________________because___________________________. The
_____cm parachute will ____________________________
______________________because ______________
______________________. I think the ____cm
parachute will ____________________________ because __
_______________________________. 
Materials:

- a large piece of nylon fabric
- 12 strings that are cut to 70 cm
- Cardboard stencils: 7cm, 14cm and 21cm in diameter circles
- 3 identical weighted objects
- Scissors
- 3 stopwatches
- Ruler
- Tape
Procedures:

1. Gather all of the materials together.
2. Measure and create 3 cardboard stencils that are 7cm, 14cm and 21cm in diameter circles.
3. Use the stencils to trace the pattern on the nylon fabric. Cut out the circles.
4. Measure where you will put the 4 holes for the strings. They need to be equal distances apart.
5. Tie the 4 strings so they are the same length.
6. Attach the weighted object to each parachute.
7. Drop the 7cm parachute from the top rung of the ladder and record the time the weight touches the ground. Repeat 4 times.
8. Repeat step 7 with the 14cm parachute.
9. Repeat step 7 with the 21cm parachute.
## Data and Observations:

<table>
<thead>
<tr>
<th>Trial</th>
<th>7cm</th>
<th>14 cm</th>
<th>21 cm</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>Average</td>
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**7cm diameter parachute:**

Trial 1: __________________________

Trial 2: __________________________

Trial 3: __________________________

Trial 4: __________________________

Trial 5: __________________________

**14 cm diameter parachute:**

Trial 1: __________________________

Trial 2: __________________________
Graph:

Make a graph that shows a comparison of the **average** landing time for the three parachutes.

- **Bar graphs** are used to compare data.
- **Line graphs** show change over time.
Conclusion:

*Include all of the following in paragraph form:*

- **Restate your hypothesis in the past tense.** *(In my hypothesis, I predicted that____________)*

- **State whether or not you proved your hypothesis.**

- **Summarize your results:** *(The average landing time for the 7cm parachute was______________. The average landing time for the 14cm parachute was______________ and the 21 cm parachute had an average landing time of__________.)*

- **Discuss any data that does not seem to fit and include any observations that you made for that trial.** *(In trial 2 for the 7 cm parachute, the landing time seemed abnormally high. The parachute landed really far to the left so it is possible that it caught a breeze. If I recalculate the average after removing this landing time it would show that the 7cm parachute had an average landing time of______)*

- **Make a statement about the overall results.** *(This project shows that the size of the canopy on a parachute does affect the landing time. The largest canopy has the most surface area which allows the most wind resistance and therefore the slowest descent to the ground.)*
Applications:

The knowledge I gained from completing this experiment will be useful to _______________
________________________________________
________________________________________
__________________________________________.

Future Research:

There were several variables that we failed to control that may have affected the results of our experiment. If I was to try this experiment again I would __________________________
______________________________________
________________________________________
__________________________________________.

Bibliography:
Acknowledgements:

I would like to thank____________________

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