1. Paper Airplane Challenge

**Introduction**

**Purpose** To construct a paper airplane that will fly 18 feet into a square area.

**Discussion**

Objects that are launched are called projectiles. The path they follow is called a **trajectory**. The motion of a projectile is described in terms of its position, velocity, and acceleration and exemplifies motion in accord with Newton’s laws, especially Newton’s second law.

**Hypothesis**

If a projectile is launched, then variables need to be considered that affect its trajectory.

**Material:** One piece of standard 8.5 x 11 paper Scissors

 6 inches of tape 2 paperclips

**Testing criteria**

* Each person/team may make two airplanes
* Each person/team gets 10 trials (if two airplanes, still 10 trials)
* Create a 1’ x 1’ square as the “target” or goal.

**Scoring**

* 1 point for outside square 3 points for on square 5 points for inside square

**Conclusions & Questions**:

1. How does the flight path of the plane compare with that of a thrown ball at the same height?
2. What adjustments were made to the plane that were significant in changing the way it traveled through the air to the target?
3. What is the average vertical acceleration of the plane? How did you find this? How come it was not equal to “g”?
4. Determine the average speed of the plane(s) during the practice launches. Use a distance approximately equal to that of the test distance. Show all work.
5. Explain the most important element for success in this activity. Be thorough.

**2. Paper football**

a) Fold a piece of paper into a football, so that you can use your fingers to flick it at least a meter in distance. Launch it from the edge of a lab table and let it hit the table at the same height. You may use the floor if your football is in the air for too long of a time. Measure the hang time and the horizontal distance.

T = \_\_\_\_\_\_\_\_\_\_(sec) dx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_(m)

* Calculate the height using the **free fall equation** and **free fall time**.

 H= \_\_\_\_\_\_\_\_\_\_\_\_\_\_(m)

* From the free fall time, find the vertical component of the velocity of the paper football as it was launched.

Vy = gt

Vy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* From the total horizontal distance covered and the time the football was in the air, find the average velocity of the football in the x direction. Can we use this as the initial horizontal component of the velocity? Explain your reasoning.

Vx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Draw a diagram showing the projectile path of the football (both x and y components) through its entire flight. From this diagram, determine the actual velocity (both components together). Use Pythagorean theorem.

V = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* What is the approximate angle of launch? Refer to the triangles you know and pick the closest angle.

Approximate Angle = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Conclusions & Questions**:

1. How does the flight path of the plane compare with that of a thrown ball at the same height?

 *The plane will be more affected by air resistance*

2. What adjustments were made to the plane that were significant in changing the way it traveled through the air to the target?

 *Streamlining the design, adding paperclips for weight*

3. What is the average vertical acceleration of the plane? How did you find this? How come it was not equal to “g”?

 *You'd have to time the fall and measure the vertical distance. Air resistance will affect the flight*

4. Determine the average speed of the plane(s) during the practice launches. Use a distance approximately equal to that of the test distance. Show all work.

 *Measure the vertical distance and the time it took to fall*

5. Explain the most important element for success in this activity. Be thorough.

*Reduce air resistance and create a streamlined design.*

**2. Paper football**

a) Fold a piece of paper into a football, so that you can use your fingers to flick it at least a meter in distance. Launch it from the edge of a lab table and let it hit the table at the same height. You may use the floor if your football is in the air for too long of a time. Measure the hang time and the horizontal distance.

T = \_\_\_\_\_\_\_\_\_\_(sec) dx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_(m)

* Calculate the height using the **free fall equation** and **free fall time**.

 H= \_\_\_\_\_\_\_\_\_\_\_\_\_\_(m)

*The path of the football is parabolic. Therefore, dy uses only ½ the hang time.*

dy

* From the free fall time, find the vertical component of the velocity of the paper football as it was launched.

Vy = gt *Use ½ the hang time here*

Vy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* From the total horizontal distance covered and the time the football was in the air, find the average velocity of the football in the x direction. Can we use this as the initial horizontal component of the velocity? Explain your reasoning.

Vx = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ *Vx = d / t*

*This is an average speed so the total distance / hang time works.*

* Draw a diagram showing the projectile path of the football (both x and y components) through its entire flight. From this diagram, determine the actual velocity (both components together). Use Pythagorean theorem.

V

V = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Vy

a

 Vx2  + Vy2  = V2

Vx

* What is the approximate angle of launch? Refer to the triangles you know and pick the closest angle.

Approximate Angle = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ *Sin a = Vy/V or Cos a = Vx / V*