Spoon Catapults - Handout #1

1. **Hypothesis:** *Write a prediction or hypothesis before starting. Hypothesize what launch angle (between 0-90°) will maximize horizontal flight distance (range).*

If I _____, then the ping-pong

ball will _____ , because _____

_____.

2. **Investigation:**

Materials needed:
- 1 ping-pong ball
- Plastic spoons
- A meter stick
- Protractor
- Tape
- Colored Pencils
- Graph Paper

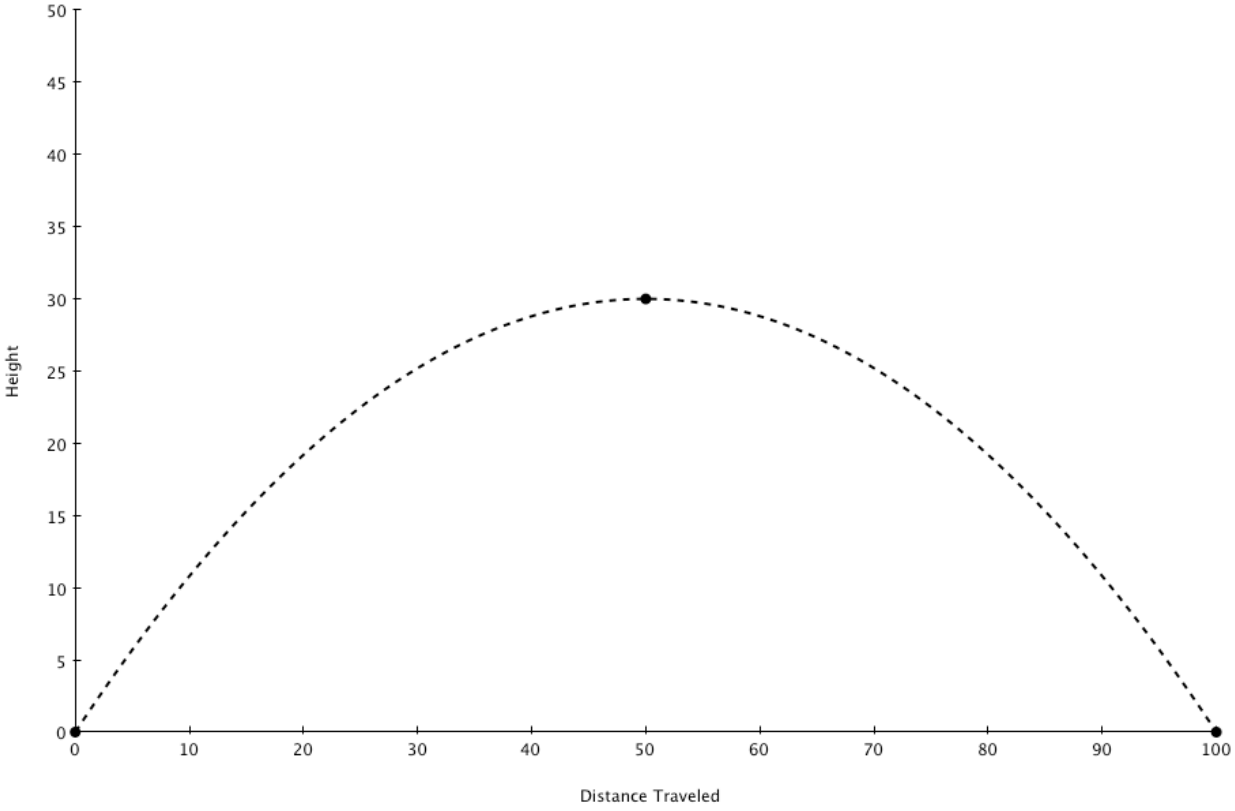
Roles: In your group of 4, you will each have one of the following roles. You will rotate roles after every 5 launches.

Launcher = person launching the ping-pong ball
Angle Manager = person holds the protractor next to catapult (spoon) for each launch to check the launch angle is accurate.
Marker = person will use the tape and mark the landing spot
Measurer = person who measures the horizontal distance from the launch to landing spot (in meters).

Procedures & Data Collection:

- Use the colored tape and mark a spot on the ground as your "launch point". All launches will start here.
- The Angle Manager and Launcher will set up at the "launch point" on the ground.
- The Angle Manager places the protractor so the center of the protractor (90°) is on the launch point. Make sure the numbers of the protractor are facing the launcher.
- Each Launcher will launch the ping-pong ball at 5 different angles (15°, 30°, 45°, 60°, 75°). Each angle is the amount the spoon top will be pulled back behind the launch point. (*Try to shoot as straight as possible)*
- After each launch, the Marker will place a piece of tape at the "landing spot", and the Measurer will measure the distance between the launch and landing spot.
- Record the launch angle and distance (in meters) of each attempt in the table below when you are "Launcher".

Launch Angle	Range (m)
15°	
30°	
45°	
60°	
75°	



3. Analysis

Using your graph paper, graph the trajectories of each ping pong ball you launched, assuming that the flight is parabolic as the example on the previous page. For this part, ***you will be estimating height***. Use a different color to indicate each trajectory and launch angle. Make sure to give your graph and axes titles and make a legend for each color / launch angle. (*Remember the vertex of each trajectory = 1/2 the range*)

4. Concluding Questions and Calculations:

1. For which angle did the ping-pong ball have the greatest range for each team member?

2. Why do you think this angle yielded the greatest range?

3. Were there any pairs of angles for which it seems the ball traveled the SAME distance (or close to the same)? If so, list the angle pairs below.

4. How accurate do you think your launch angles were? Can you think of any way you could increase the accuracy of the projection launch angles?

Calculations:

The formula used to show the relationship between the distance traveled, the initial velocity and the launch angle is as follows:

$$D = (V_0^2 \cdot \sin 2\Theta) / g$$

D = distance (range)

V_0 = initial velocity

Θ = launch angle

g = 9.81 m / s^2 (acceleration of gravity)

1. Using the formula above, calculate the initial velocity of for each of your launches. Record your results below.

Launch Angle	Horizontal Distance (m)	Velocity (m/s^2)

2. How “consistent” were the velocities of your launches? If they varied, why do you think that happened? Did you notice any patterns?

Evaluation Questions:

1) Did the angle from which you launched the ball affect the range? Why or why not?

2) Can projectiles have the same range but different trajectories? Explain, why or why not.

3) How did initial velocity affect the range that the ball traveled?

4) When Xavier launched his rocket from 25°, it traveled 35 meters. What was the initial velocity of his rocket?

5) If you wanted another rocket to travel 35 meters and it has the same initial velocity, what other launch angle could you use (other than 25°) to make it go the same distance?

6) Summarize your findings and what you learned from this investigation in a four to five sentence paragraph.