LAB: "Bulls Eye"

Date _____

Last Name _____, First _____ per ___

Problem:

How can one predict where a projectile object will land?

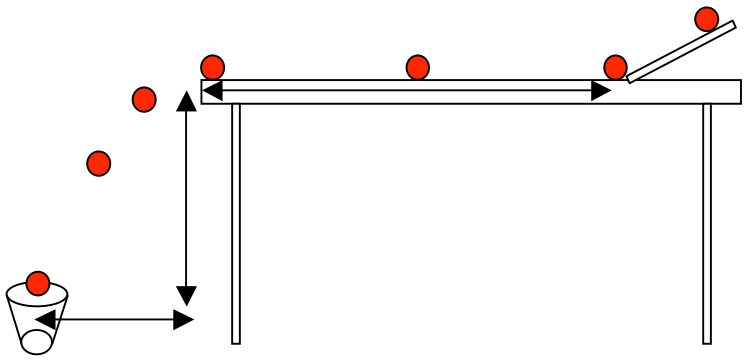
Background: There are two components of projectile motion, horizontal and vertical. Each component must be calculated separately. Projected objects have the variable characteristics of velocity (v), time (t), distance (d), and acceleration (a). Derived formulas can be used to calculate any of the variables as long as the other variables are known.

As a steel ball accelerates down a ramp it reaches its top speed at the bottom. If the steel ball continues to roll across a horizontal surface like a table top, it will travel at a constant speed. If the steel ball rolls off the edge it will continue to travel at the constant horizontal speed. Gravity will pull it downward and it will increase its vertical speed until it hits the ground.

The objective of this challenge will be to predict where the steel ball will land. To demonstrate that you have predicted correctly, you will place a cup on the spot that you predict. You will only get one try to roll the ball off the table and land it in the cup. Call your teacher over when you are ready to roll.

Materials:

Steel ball
ramp,
table top,
wood block,
meter stick,
stop watch,
plastic cup



Procedure:

Step 1. Determine the horizontal speed

1. Set up an inclined plane as a ramp on one end of the table and the wood block at the other end.
2. Test to see that the steel ball will roll straight but do not allow it to drop off the table.
3. Roll the ball down the ramp and start the timer as soon as it hits the table top. Stop the timer when it hits the barrier at the other end of the table. Conduct three trials and find the average time. Record the time in a table.

Trial	Time (seconds)
1	
2	
3	
total	
Average	

4. Use the meter stick to measure the distance from the point at which the ball hits the table top and the point at which the ball hits the barrier. Record the distance.

d = ____meters

5. Use the formula **$s = d/t$** to calculate the horizontal speed of the steel ball. Show work.

s = ___ meters/sec

Step 2. Determine the <u>time</u> for the ball to drop to the ground

1. Measure the distance from the table top to the floor. Record it.
2. Remember that you are going to put a cup on the floor so measure the height of the cup. Record it.
3. Subtract the height of the cup from the height of the table top. This is your actual distance to the target. Record it.

d = ___ meters

4. Use the formula **$t=\sqrt{2d/a}$** to calculate the time for the ball to drop to the ground. Remember: **$a = 9.8m/s/s$**. Show work.

t= ___ seconds

Step 3. Determine the <u>horizontal distance</u> the ball travels before it hits the ground

1. Use the formula **$d = st$** to calculate the horizontal distance the ball will travel before it hits its target.

d = ___ meters

Step 4. Set up the target cup.

1. Use the meter stick to measure and mark the horizontal distance from the point where the ball leaves the table to the point where it will hit the ground. Place the cup on this point.
2. Go get your teacher and get ready to roll.

Conclusion:

1. Were you successful in placing the cup at the right distance? Get your teacher's signature as proof.

2. If you were not successful, the how far did the ball land in front or behind the cup?

3. Do you think NASA scientists use calculations like this to determine where a space capsule re-entering the atmosphere will land?

4. What factor that might have had an effect on the results did we not take into consideration when we made our calculations?