Do not write on these papers. Only write on the "grade sheet."

WARNING

DO NOT SHOOT ANYTHING OTHER THAN THE PLASTIC BALL IN THE LAUNCHER. Failure to follow this rule will result in an instant "F."

OVERVIEW

You will launch a ball straight up and use the photogate to determine its initial speed. Using this data, calculate the ball's initial velocity. Then angle the launcher somewhere between 71 and 85 degrees. Make some calculations as to where the ball will land. Place a target on the floor indicating the landing spot. Cover up this sheet with a piece of carbon paper. Upon receiving the teacher's permission, launch the ball and hit the target on the first try. The carbon paper will leave an impact mark on the target sheet where the ball lands. Finish by calculating the percent error.

Materials

Photogate/CBL/TI-84	Ball Launcher
Yellow plastic ball	Meter stick
Plumb Bob (share with other groups)	C-Clamp
"Grade sheet"	Target sheet

INSTRUCTIONS

Using a "C-Clamp" attach the launcher to the table as shown.

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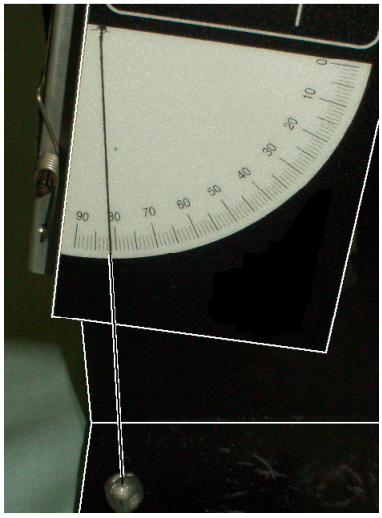
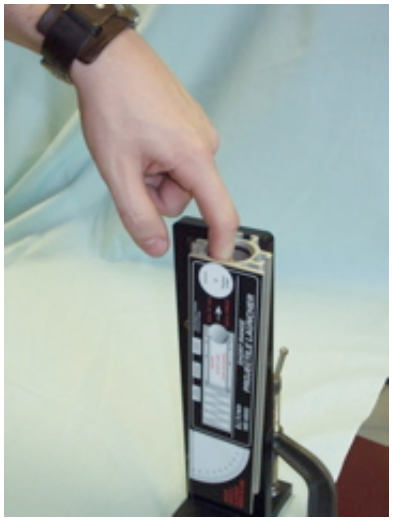
The bottom of the launcher has a protractor. This will tell you the angle of the launcher. When you set this up, adjust it so that it reads 90°. The protractor part of the launcher is shown to the right.



Adjust the launcher such that it is pointing straight up, 90°. To easily adjust the launcher's angle, loosen or tighten the two black bolts on the back of the launcher. These bolts are shown to the right.

To load the launcher, place a yellow ball in the top and push down with your finger. Push down until you hear one click. Your finger will only need to go in about 1.5 inches. The launcher has three launch positions or "clicks." The two higher launch positions decrease accuracy. Do not use them. It you accidentally push the ball down too far, hold you hand on top of the launcher and launch. The ball will not hurt your hand.



Launch the ball by pulling on the lever on the launcher's side; as shown to the right.

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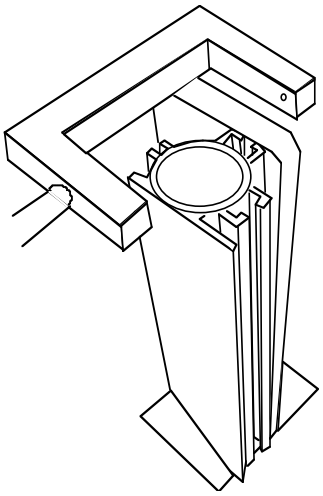
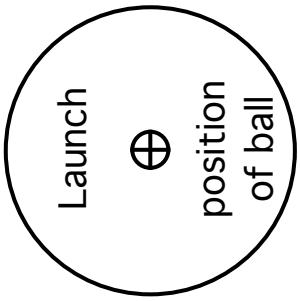
Launch the ball straight up **using the lowest setting**.



Orient the photogate across the top of the launcher. Make sure the holes, where the beam crosses the photogate goes across the center of the hole. Follow the instructions on the photogate sheet and use the gate method to measure the velocity of the ball. The ball's diameter is 0.0254 m.

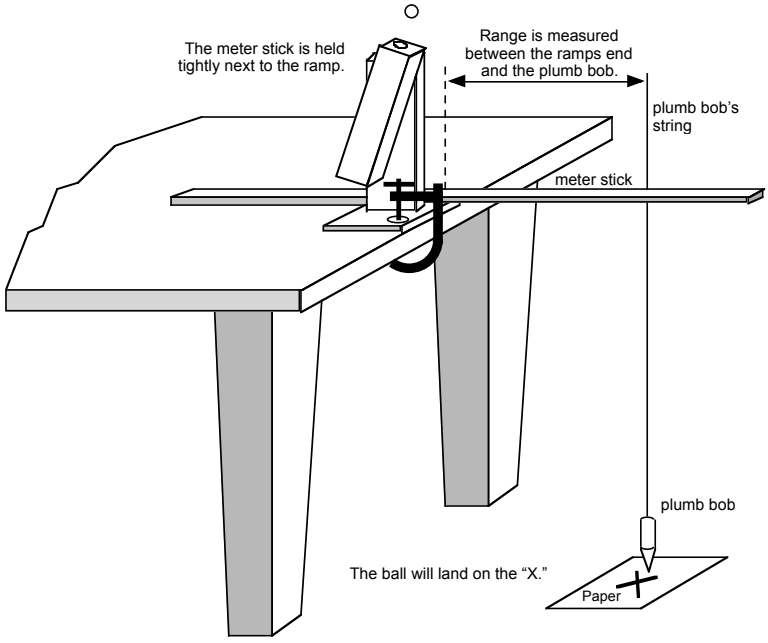
Get three reliable results and write them on the grade sheet. Take an average of these initial velocities. When the launcher is tilted the ball will fire out at this same initial velocity.

On the side of the launcher, near the top is a picture of a ball. This is the location where the plastic ball becomes a projectile. Measure from the bottom of this large picture to the ground to get the distance the ball falls. Record this number **on the grade sheet**.



Decide on a launch angle between 71 and 85 degrees. Calculate the range of the ball to where it will land on the floor. Show your calculations **on the grade sheet**.

The horizontal distance is measured from the center of the "Launch position of the ball" picture. Look for the "+" sign on the picture. Use the plumb bob to get the exact location of the landing spot. Place the target sheet here and the carbon paper on top of the paper. **DO NOT LAUNCH THE BALL WITHOUT THE TEACHER'S PERMSSION.**



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Call the teacher over. You will launch the ball **ONCE,** after the teacher gives you permission. **Do not launch the ball without the teacher watching**. When the ball lands, it will leave a mark on the target sheet. This landing mark determines your starting point for your grade. The rest of the grade comes from your completeness of the work.

If you miss all the marks, the teacher will double check your work –if it's not neat and complete you will lose more points at this time. If a mistake is found, then you will get the chance to launch again. However, the second time you launch you will take your score and subtract 2 points.

The teacher will write this started score **on the grade sheet**.

Upon landing in the circles and receiving a starter score, calculate the percent error **on the grade sheet**.

Turn in one copy of the grade sheet per group.