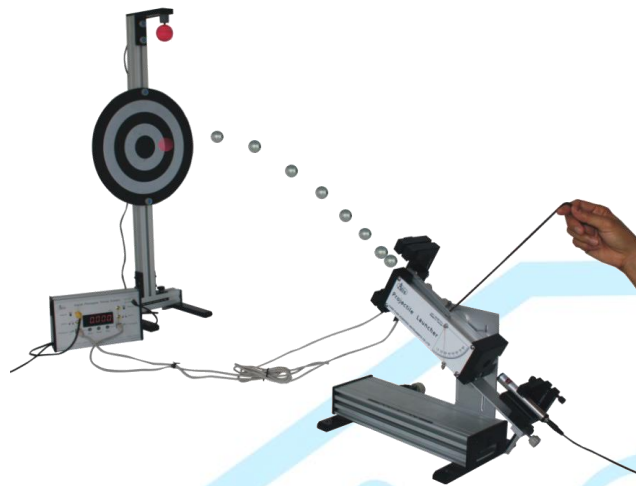


# Projectile Motion-Manual

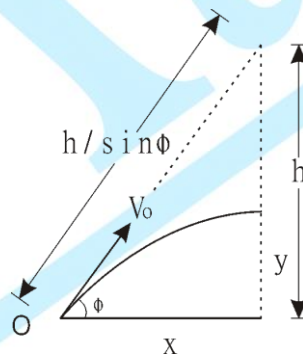


## Purpose

In this experiment, we shoot a free falling ball by using a projectile to verify the theory of projectile motion.

## Theory

We observe the trajectories of free fall and projectile motions. First, we create points at the (x,y) coordinates.



When shooting:

$$x = v_0 \cos \phi \cdot t$$

$$y = v_0 \sin \phi \cdot t - \frac{1}{2} g t^2$$

When  $y \geq 0$ , a free falling ball is hit by a projectile, so

$$y = v_0 \sin \phi \cdot t - \frac{1}{2} g t^2 \geq 0$$

$$\therefore v_0 \sin \phi \cdot t \geq \frac{1}{2} g t^2 \quad (1)$$

Then, we know from the x coordinates

$$t = \frac{x}{v_0 \cos \phi} \quad (2)$$

Substitute equation (2) into equation (1)

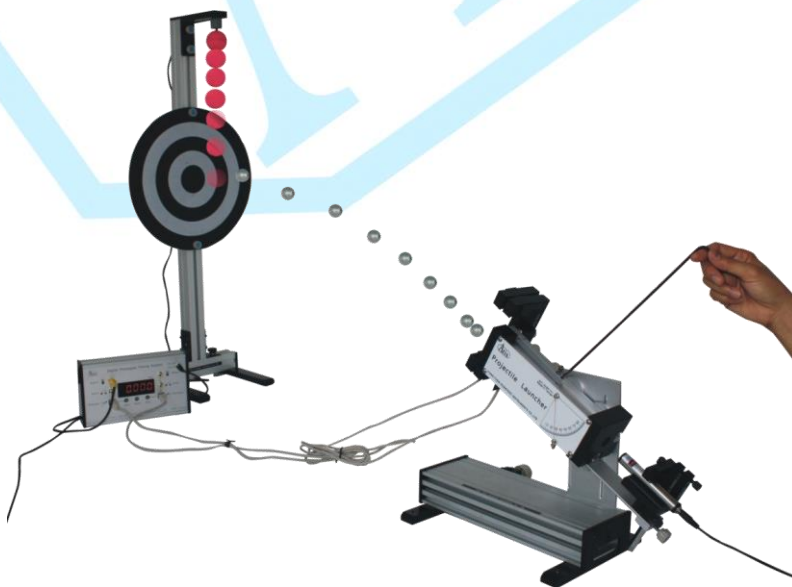
$$\therefore v_0 \sin \phi \geq \frac{g x}{2 v_0 \cos \phi}$$

$$v_0^2 \geq \frac{g x}{\sin 2\phi}$$

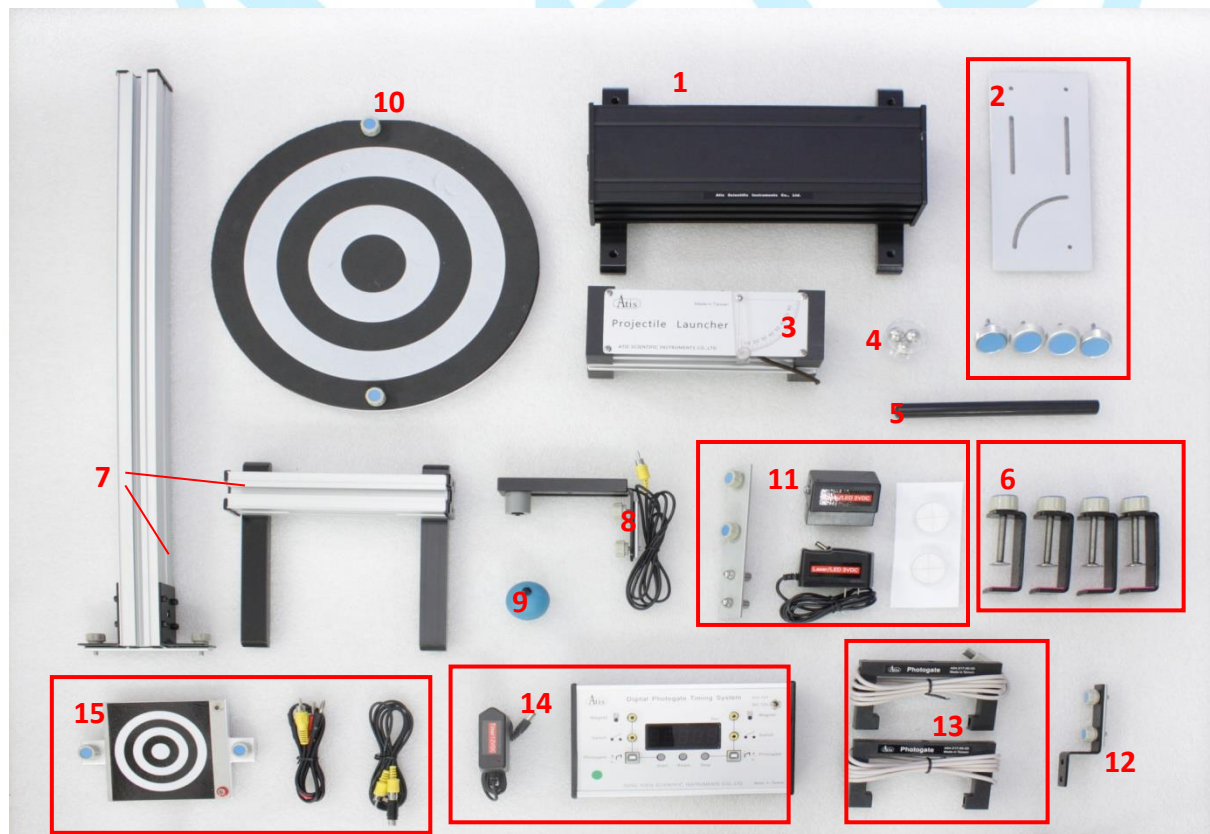
$$\therefore v_0 \geq \sqrt{\frac{g x}{\sin 2\phi}}$$

This is the suitable condition for this experiment. When the condition is satisfied, the hitting situation happens.

## Instrument



No	Accessory	Qty	No	Accessory	Qty
1.	Multi-function launcher( include a slide)	1	2.	Launcher holder (large knob x 4)	1
3.	Barrel (including slide*1)	1	4.	Set of steel balls (D16mm×3)	1
5.	Loading stick	1	6.	C-shaped clip	4
7.	Experiment set of falling body	1	8.	Electromagnet device (include AV end wire)	1
9.	Falling body	1	10.	Concentric target	1
11.	Accessory of laser arming (include laser box, laser holder (fixable slide and knob), power supply 3VDC and crosshairs x 2)	1	12.	Photogate set (include slide and knob*2)	1
13.	Photogate sensor(B) (include fixable knob)	2	14.	Photogate timer (include power supply 12VDC)	1
15.	Timing target (with connecting wire)	1			



## Procedure

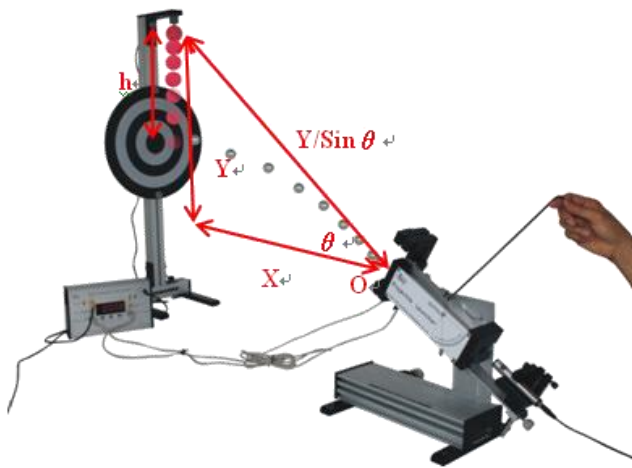


Fig. 1 Set up



Digital Photogate Timing System

1. Experimental device set up as shown in Fig. 1 and 2. First fix the distance between the projectile launcher and the shooting target. Then aim the launcher at the ball using laser light.
2. Load in the steel ball into the launcher pipe.
3. Connect the power, photogate and electromagnet to the timing system and reset.  
Note: When the steel ball passes through the photogate, the electromagnet power will be cut off to make the free-falling ball to fall at the same time.
4. Put the ball on the top of the target base to be ready as shown in Fig. 3.



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