

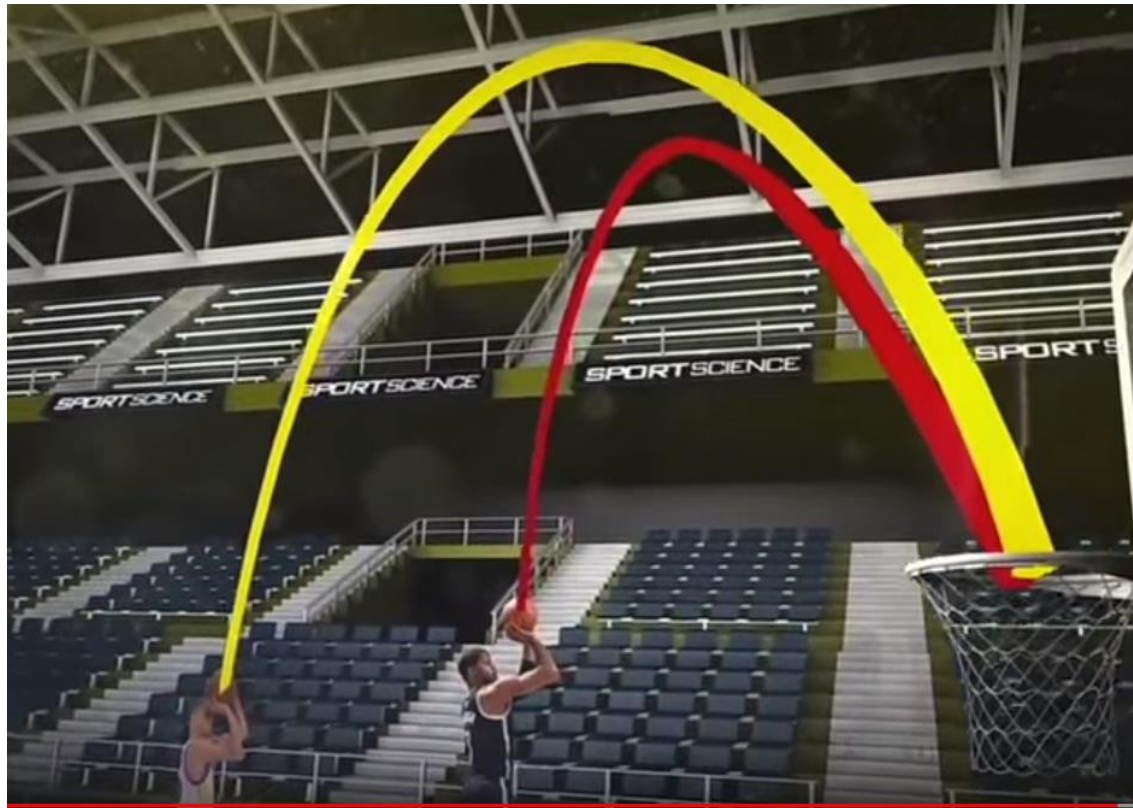
Physics Laboratory – I

4th Week

Kinematics



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- <https://www.youtube.com/watch?v=mCC-68LyZM> misconception about free fall
- <https://www.youtube.com/watch?v=E43-CfukEgs> Galileo's experiment
- <https://www.youtube.com/watch?v=0ISx0445xXc> sports & projectile motion



Experiment

Projectile Motion

Objective

- To Investigate and **understand the kinematics of motion in two dimensions**. Projectile motion provides the perfect example for this investigation as one component of this motion is constant velocity and the other is constant acceleration.
- This experiment is basically to **test a range of existing formulas** for projectile motion and the independence of its two components thus understanding the kinematics of motion in two dimensions.

Parts of the Experiment

1) Horizontal Shoot

Measure (x, y_0) , calculate V_0, t_f

2) Projectile motion

Measure (x, y_0) , calculate, t_f

3) Projectile motion with photogates

Measure t_f , calculate x, V_0

Theory

Projectile Motion

Motion In Two Dimensions

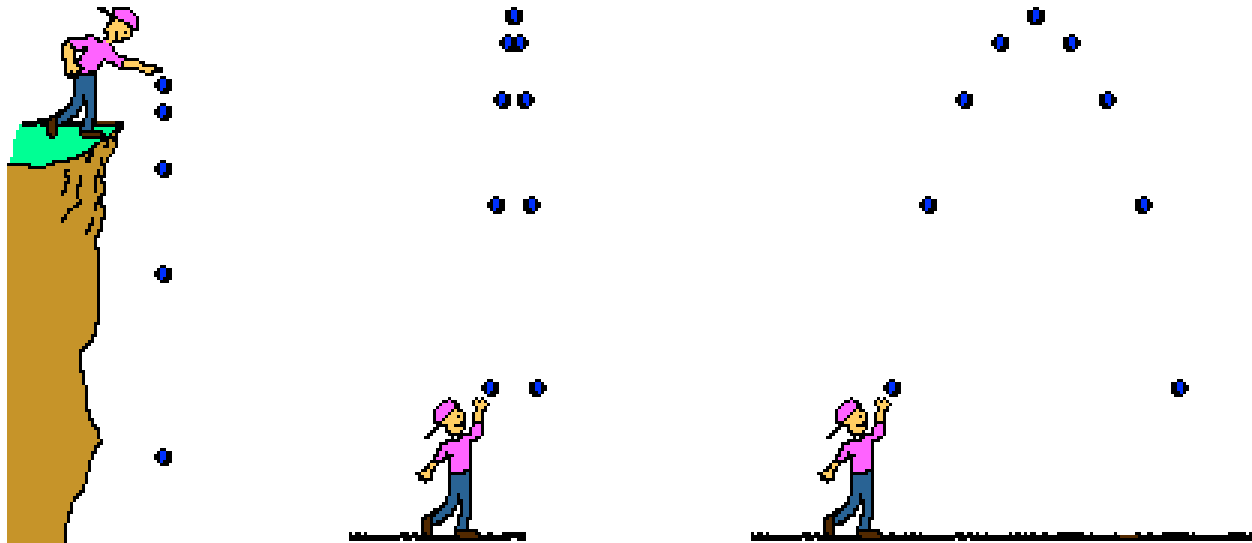
Projectile motion is a **combination of horizontal** motion and **vertical** motion.

The horizontal motion of a projectile is **constant** because no **gravitational** force acts horizontally



A **projectile** is any object that moves through the air or through space, acted on only by gravity (and air resistance).

Types of Projectiles



The motion of a projectile is determined only by the object's **initial velocity**, **launch angle** and **gravity**.

Projectile Motion

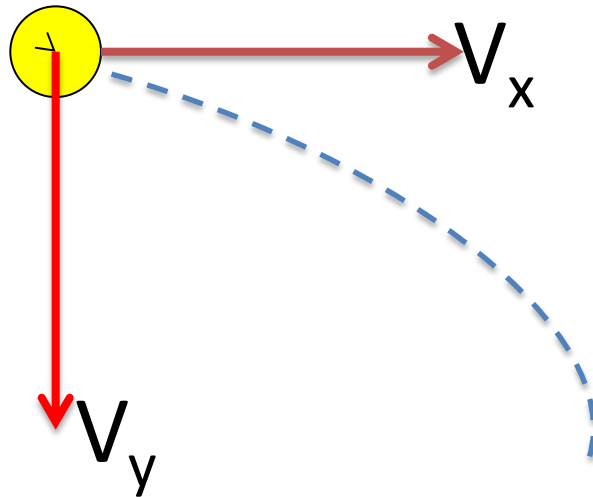
The path of a projectile is called **its trajectory**. Some examples of projectiles include ...

- a baseball that has been pitched, batted, or thrown
- a bullet the instant it exits the barrel of a gun or rifle
- a bus driven off an uncompleted bridge
- a moving airplane in the air with its engines and wings disabled
- a runner in mid stride (since they momentarily lose contact with the ground)
- the space shuttle or any other spacecraft after main engine cut off

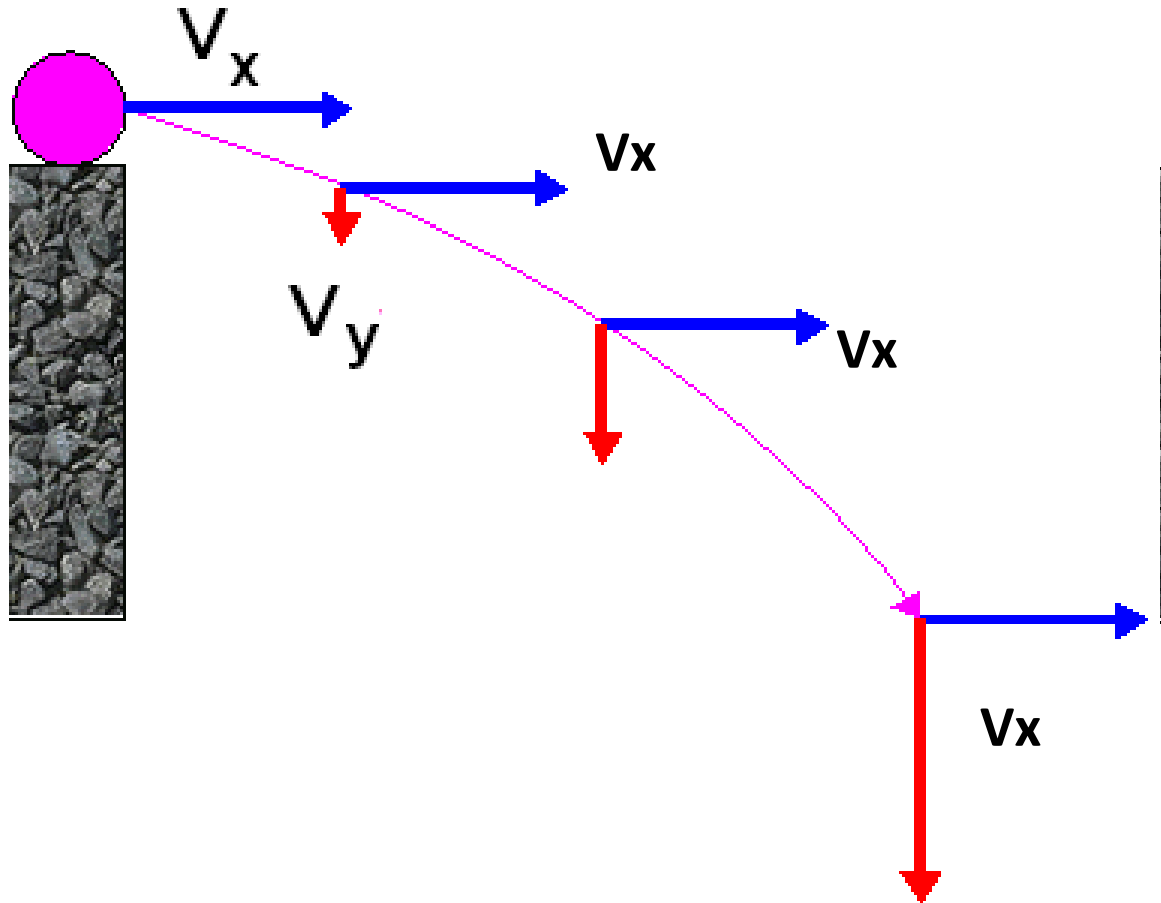


**some
Examples
of
Projectiles**

The vertical motion of a projected object is *independent* of its horizontal motion.



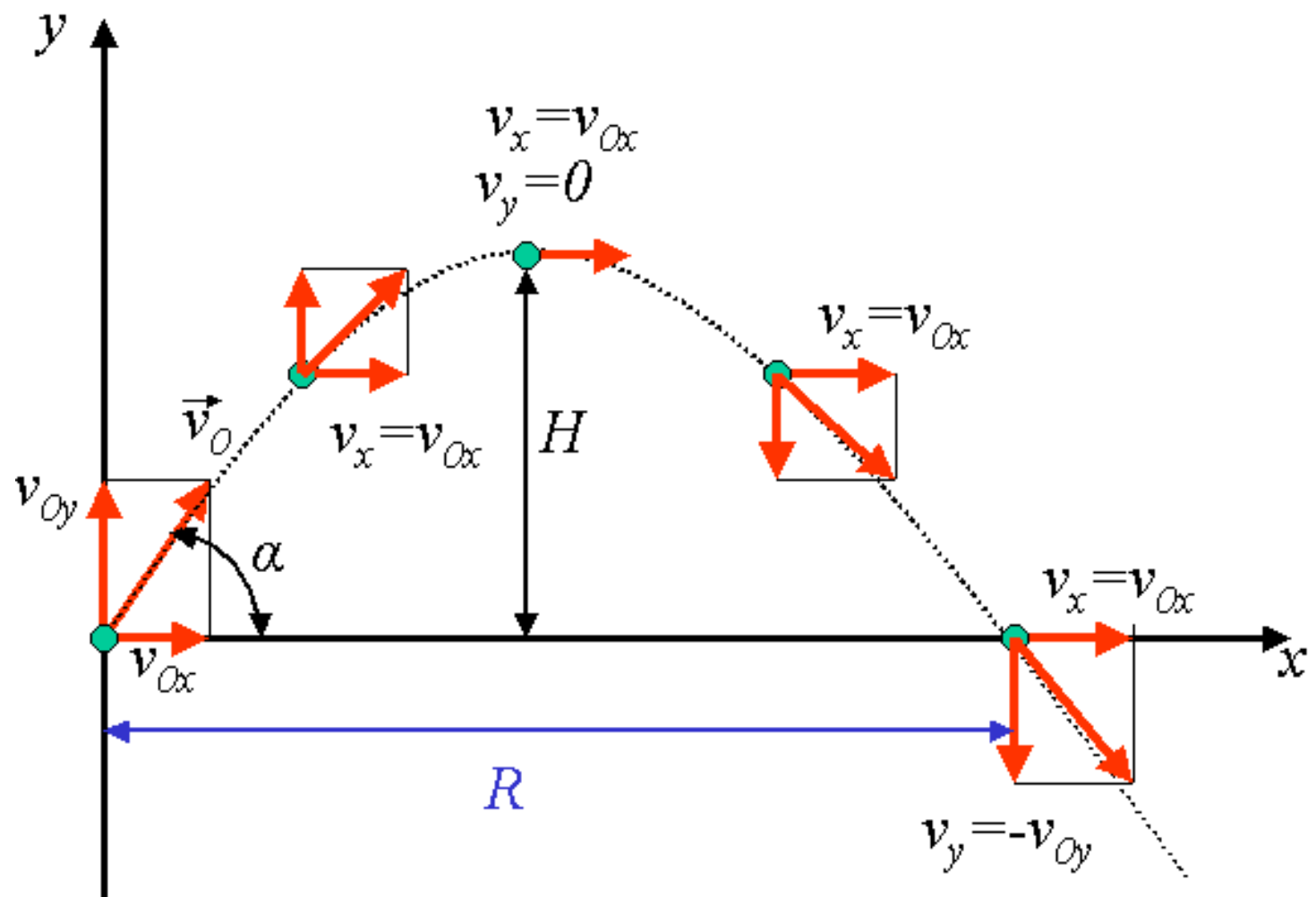
The **x-component** of a projectile's motion is there from the start, and stays the same the entire time.



The **y-component** of a projectile's motion doesn't even exist at the beginning, but grows bigger as the object falls.

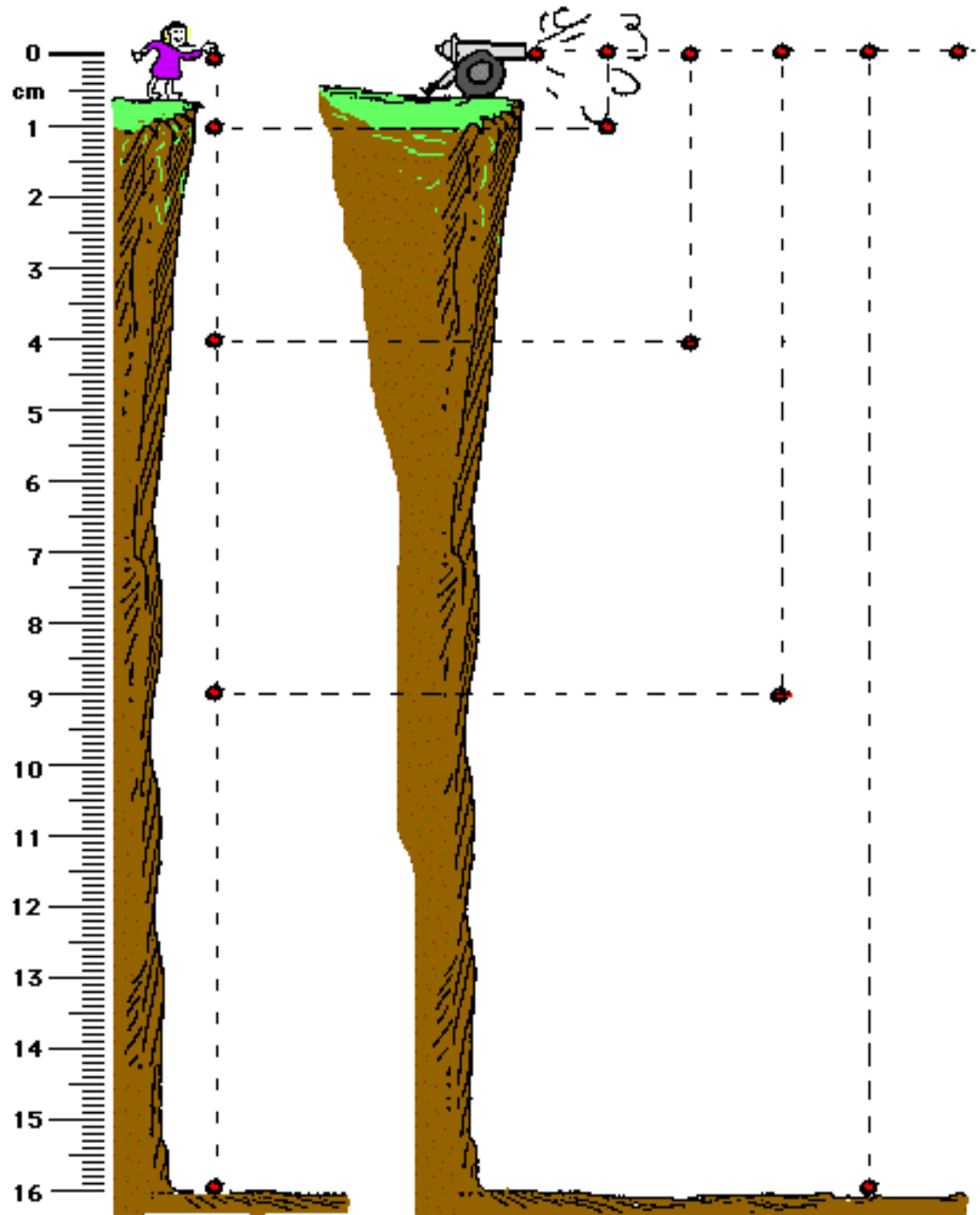
Projectile Vectors

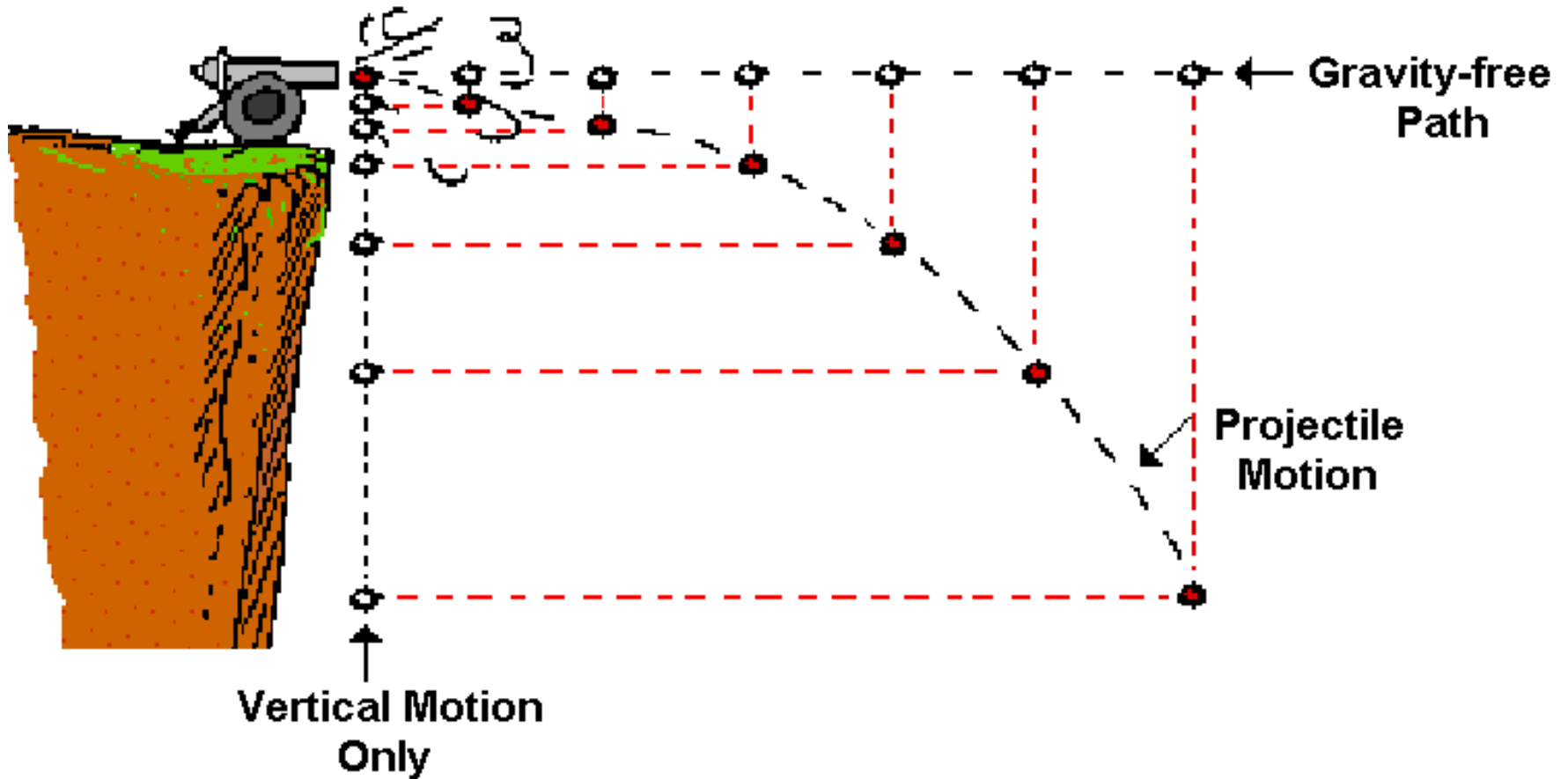
Horizontal and vertical components are represented as vectors.



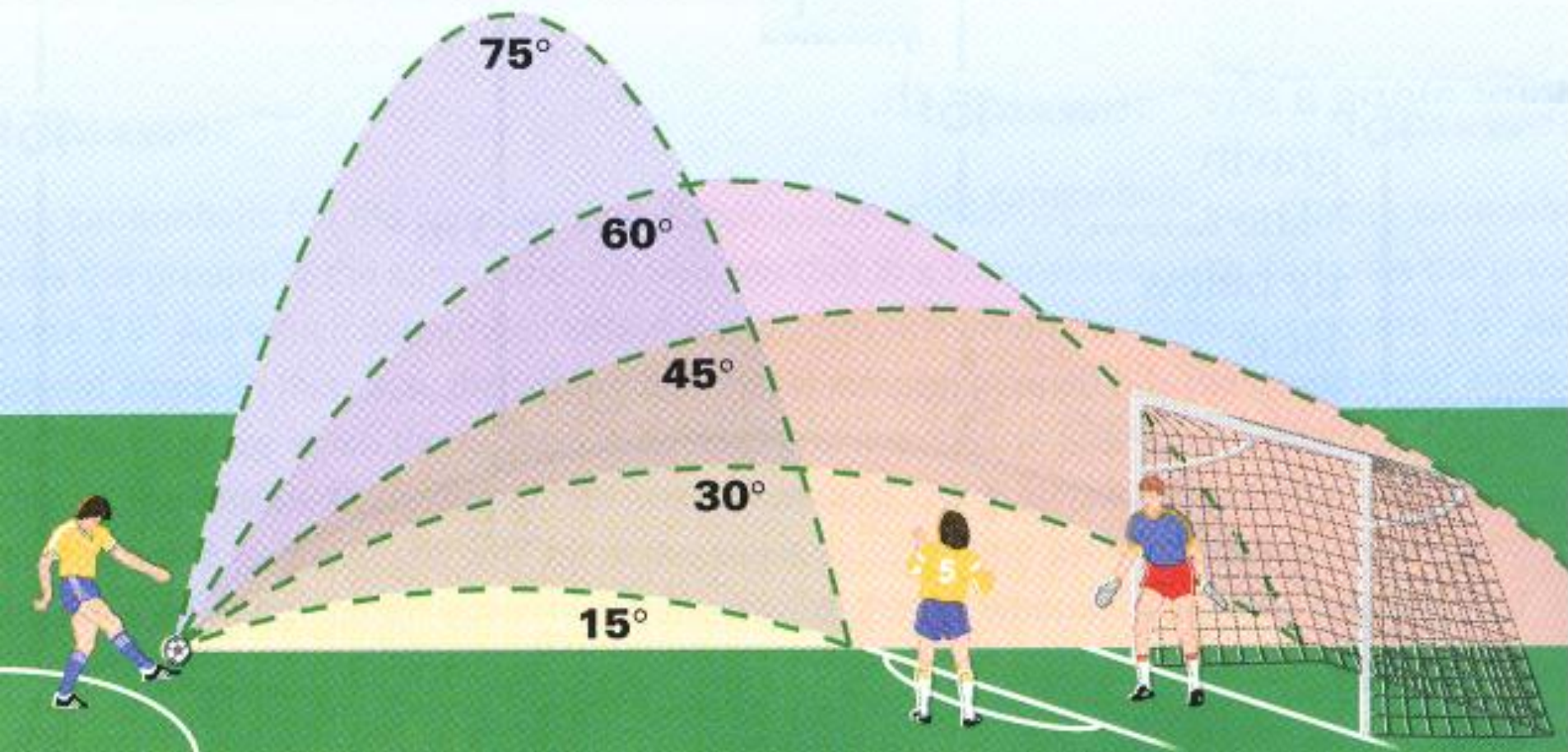
An object projected horizontally will reach the ground in the same time as an object dropped vertically.

No matter how large the horizontal velocity is, the downward pull of gravity is always the same.





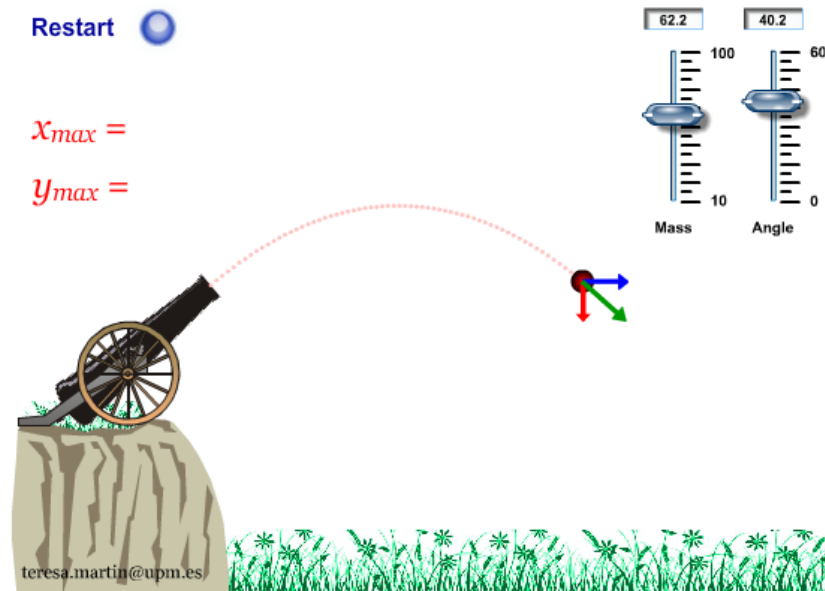
The cannonball falls the same amount of distance as it did when it was merely dropped from rest



If projectiles are launched at the same speed, but at different angles, the height and range is of the projectile are affected.

- <http://physics-animations.com/Physics/English/mech.htm>

- <https://sites.google.com/site/physicsflash/home/parabolic-motion>





Experiment

Projectile Motion

- **Equipment Needed**

- Projectile Launcher and plastic ball
- Meter stick/ruler
- Carbon paper
- White paper Sticky tape

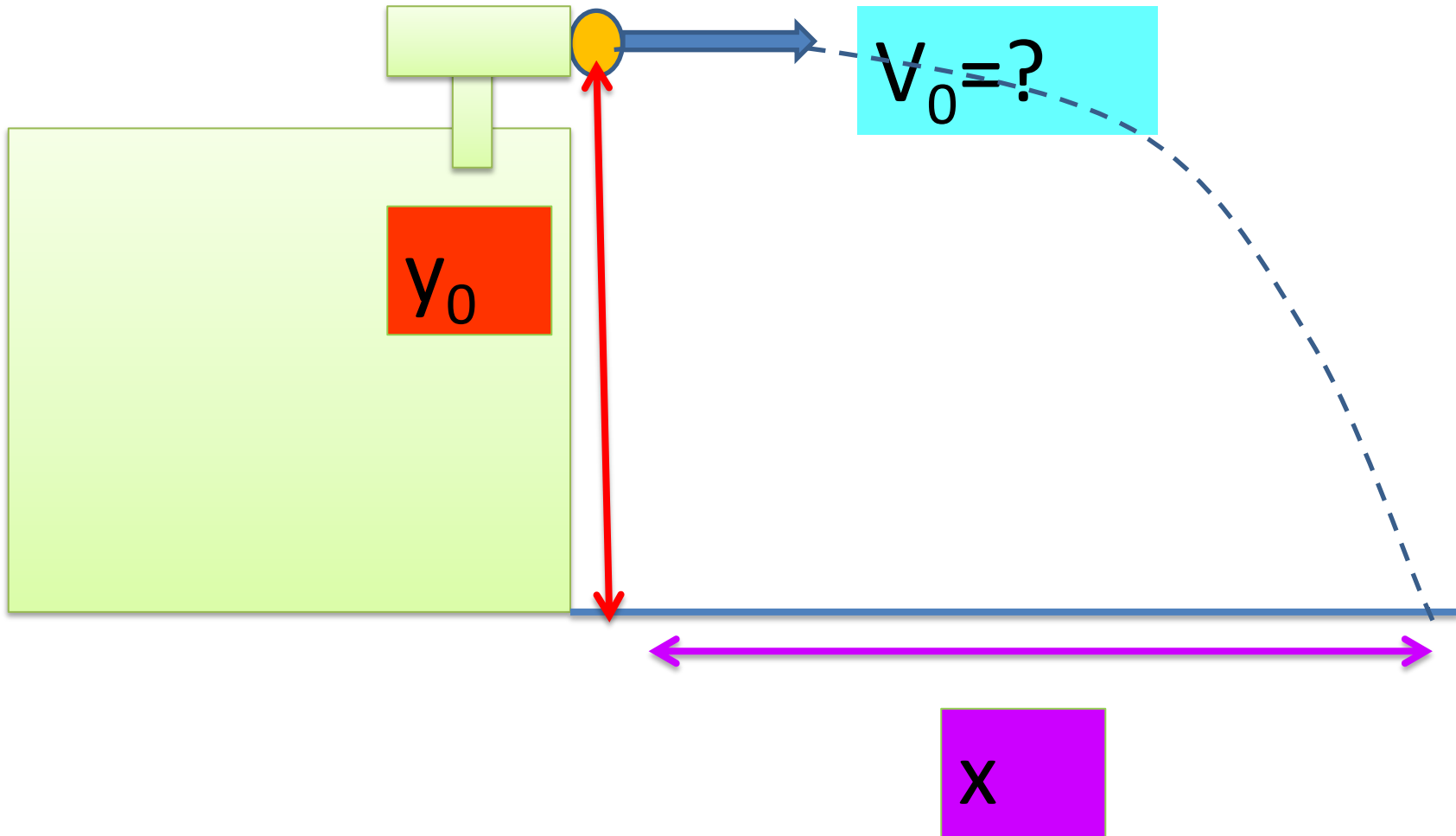
Purpose

- The purpose of this experiment is to predict and verify the **initial velocity of a ball** launched at an angle.
- $(x = V_{0x} \cdot t_f = V_0 \cdot \cos(a) \cdot t_f)$
- $a=0 \Rightarrow x = V_0 \cdot t$
- **The initial speed** of the ball is determined by shooting it horizontally and measuring the **range of the ball** and **the height of the Launcher**.

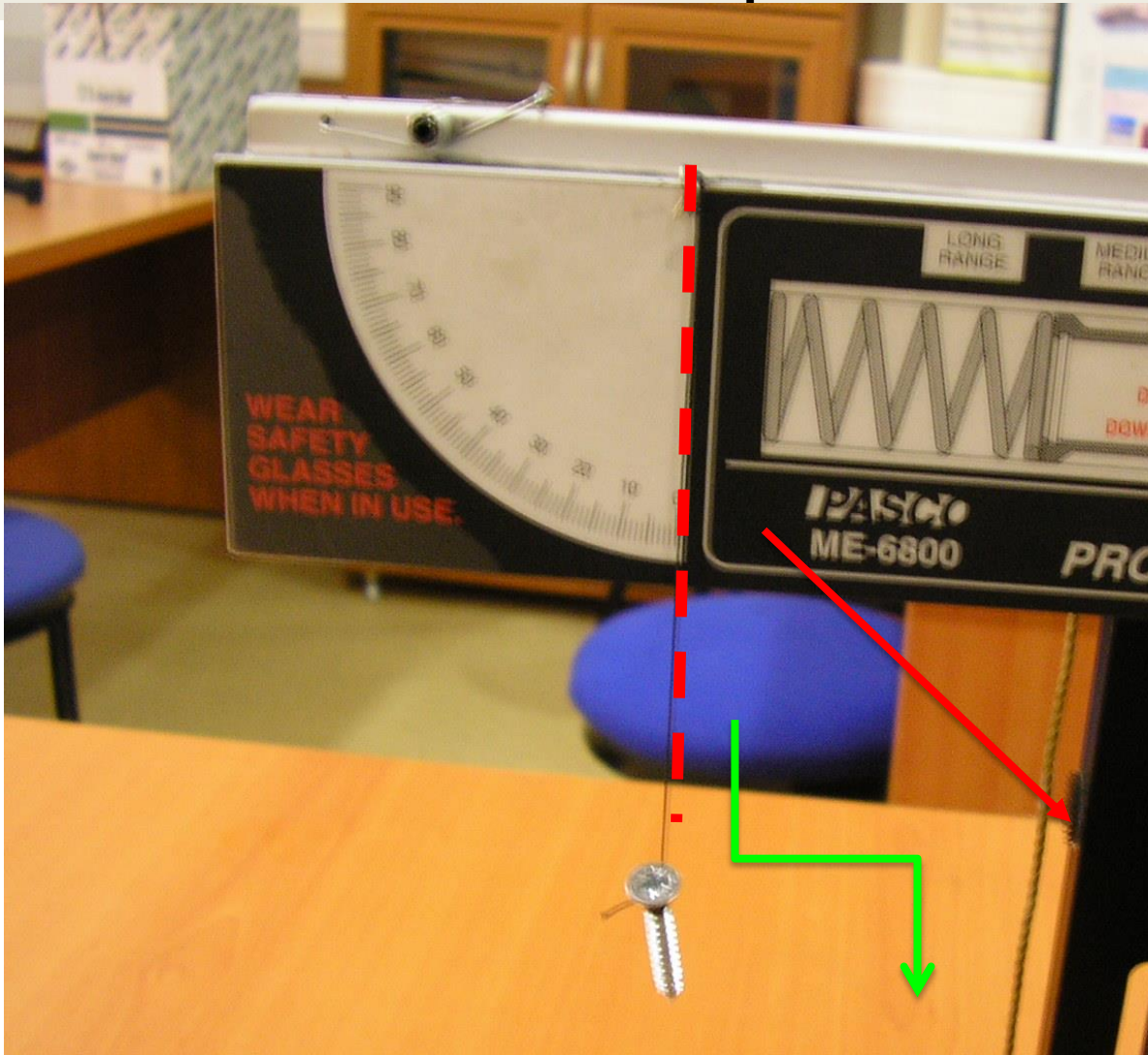
Theory

- **Initial Horizontal Speed**
- For a ball shoot **horizontally with an initial speed**, v_0 , the horizontal distance travelled by the ball is given by
- $x = v_0 t$, \ggggg $v_0 = x/t$
- where t is the time the ball is in the air. (Neglect air friction.)
- The vertical distance of the ball is the distance it drops in time t given by $y = (1/2) gt^2$
- **The initial speed can be determined by measuring x and y .** The time of flight, t , of the ball can be found using and the initial horizontal speed can be found using $t = (2y/g)^{1/2}$

Problem: to find the initial velocity



Setup



Plumb line
(çekül)

Setup

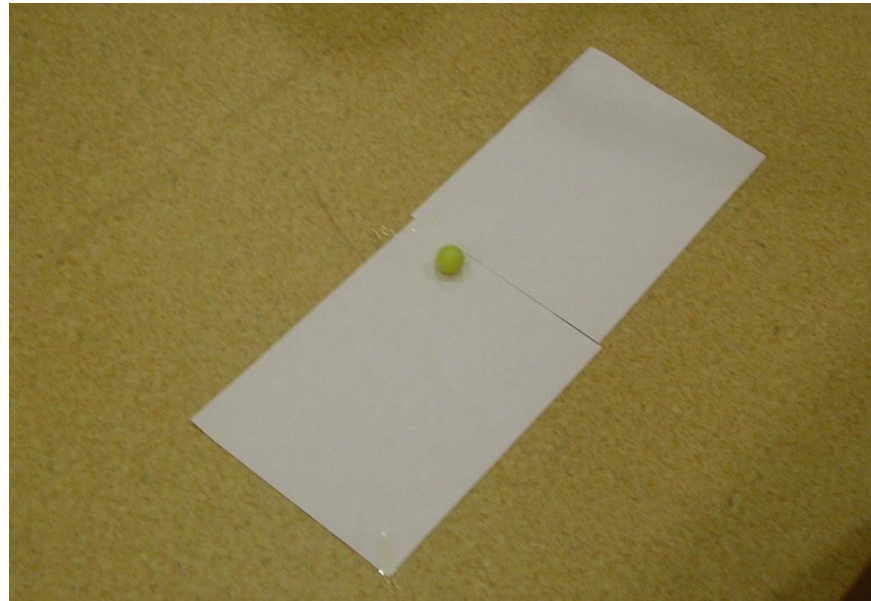
1. Clamp the Projectile Launcher to table or other horizontal surface. Mount the Launcher near one end of the table.
2. Adjust the angle of the Projectile Launcher **to zero** degrees so the ball will be launched horizontally.



Determining the Initial Horizontal Speed of the Ball

1. Put a plastic ball in the Projectile Launcher and use the ramrod to cock it at the short range position.
2. Fire one shot to locate where the ball hits the floor. At that point, tape a piece of white paper to the floor.

- Place a piece of carbon paper (carbon-side down) on top of the white paper and tape it in place.
- When the ball hits the carbon paper on the floor, it will leave a mark on the white paper.





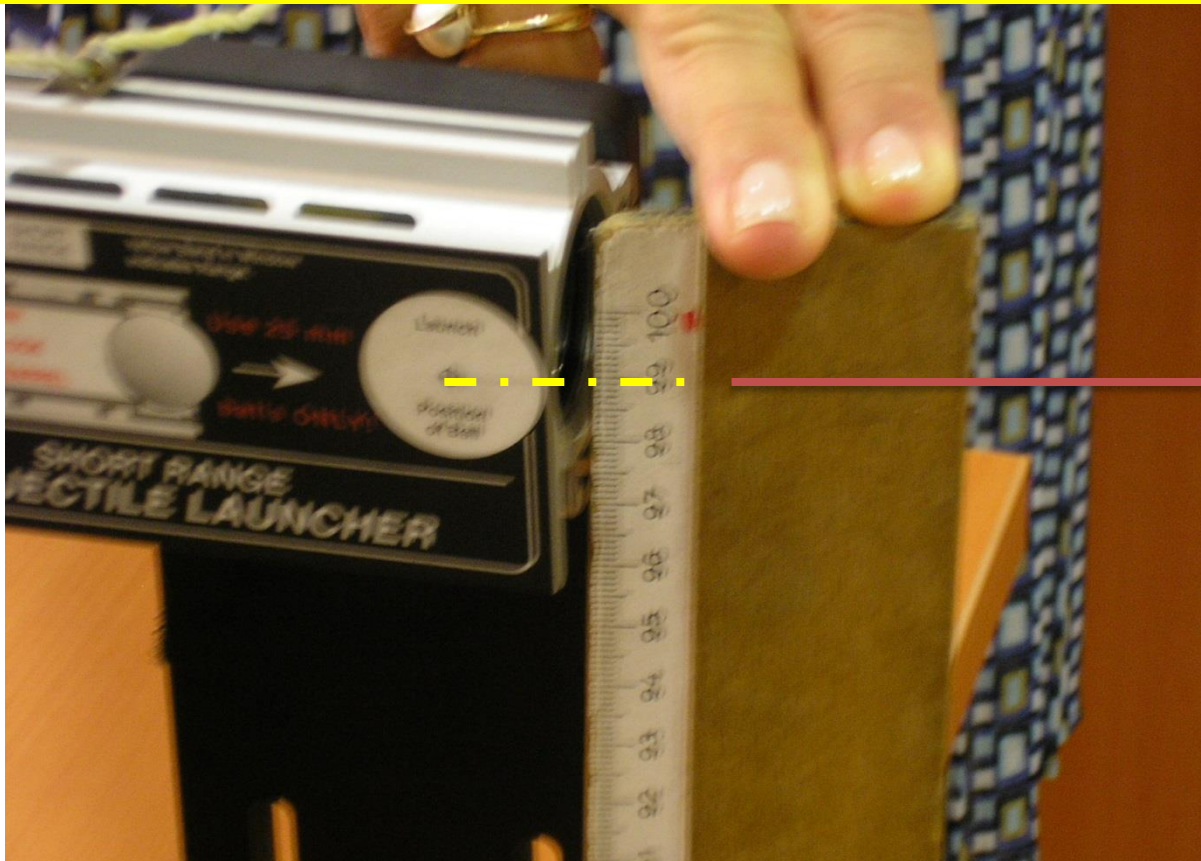
3. Measure the vertical distance from the bottom of the ball as it leaves the barrel to the floor. Record this distance in the Data Table.

The “Launch Position of Ball” in the barrel is marked on the label on the side of the Launcher.

4. Use a plumb bob to find the point on the floor that is directly beneath the release point on the barrel. Measure the horizontal distance along the floor from the release point to the leading edge of the piece of white paper. Record the distance in the Data Table.

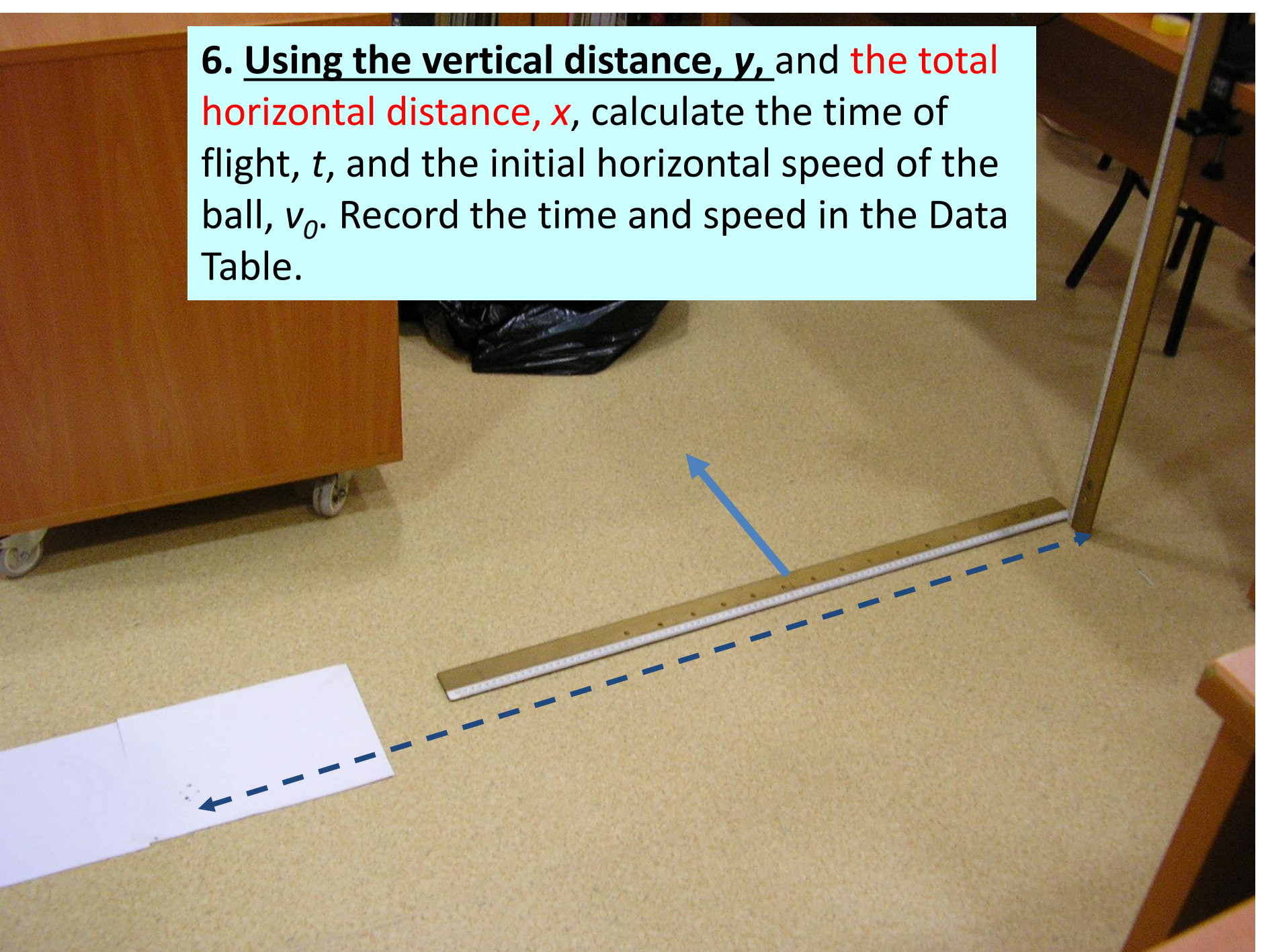


- 5. Carefully remove the carbon paper and measure from the leading edge of the White paper to each of the ten dots. Record these distances in the Data Table and find the average. Calculate and record the total horizontal distance (distance to paper plus average distance from edge of paper to dots).
- 6. **Using the vertical distance, y ,** and the total horizontal distance, x , calculate the time of flight, t , and the initial horizontal speed of the ball, v_0 . Record the time and speed in the Data Table.



**Measure
vertical
distance y**

6. Using the vertical distance, y , and **the total horizontal distance, x ,** calculate the time of flight, t , and the initial horizontal speed of the ball, v_0 . Record the time and speed in the Data Table.



Data Table A: Determine the Initial Speed

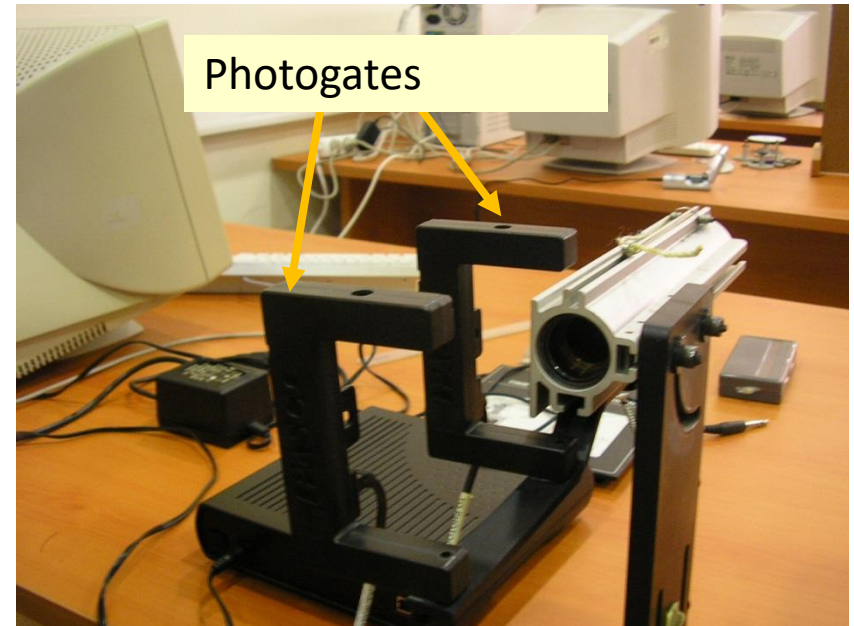
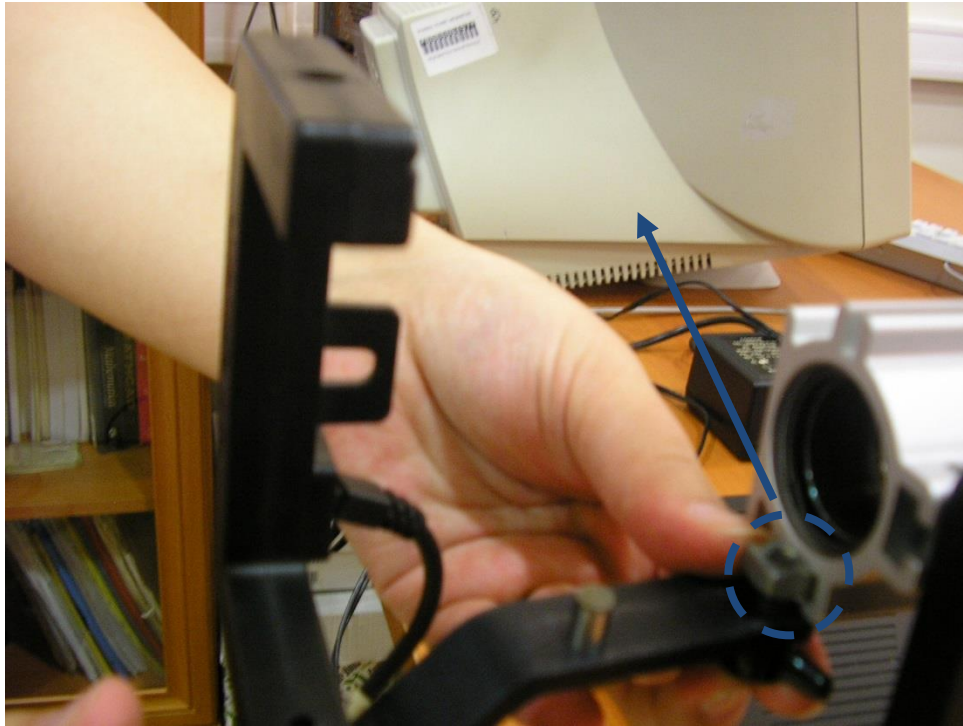
Vertical distance = _____ Horizontal distance = _____

Calculated time of flight = _____ Initial speed = _____

Table 1.

Trial	Horizontal Distance (range) (m)
1	
2	
3	
4	
5	
Average	

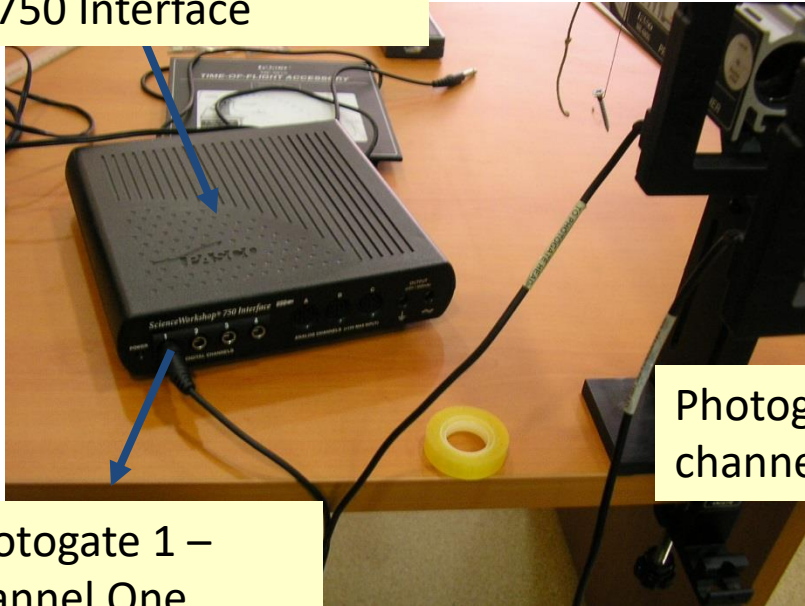
Projectile Motion Using Photogates



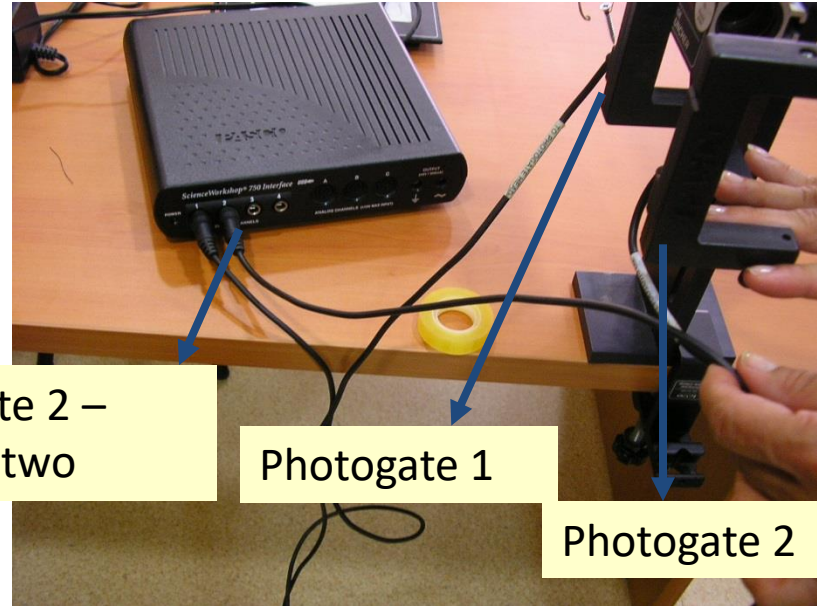
Purpose

The purpose of this experiment is to predict and verify the range of a ball launched at an angle. Photogates are used to determine the initial speed of the ball.

Science Workshop 750 Interface



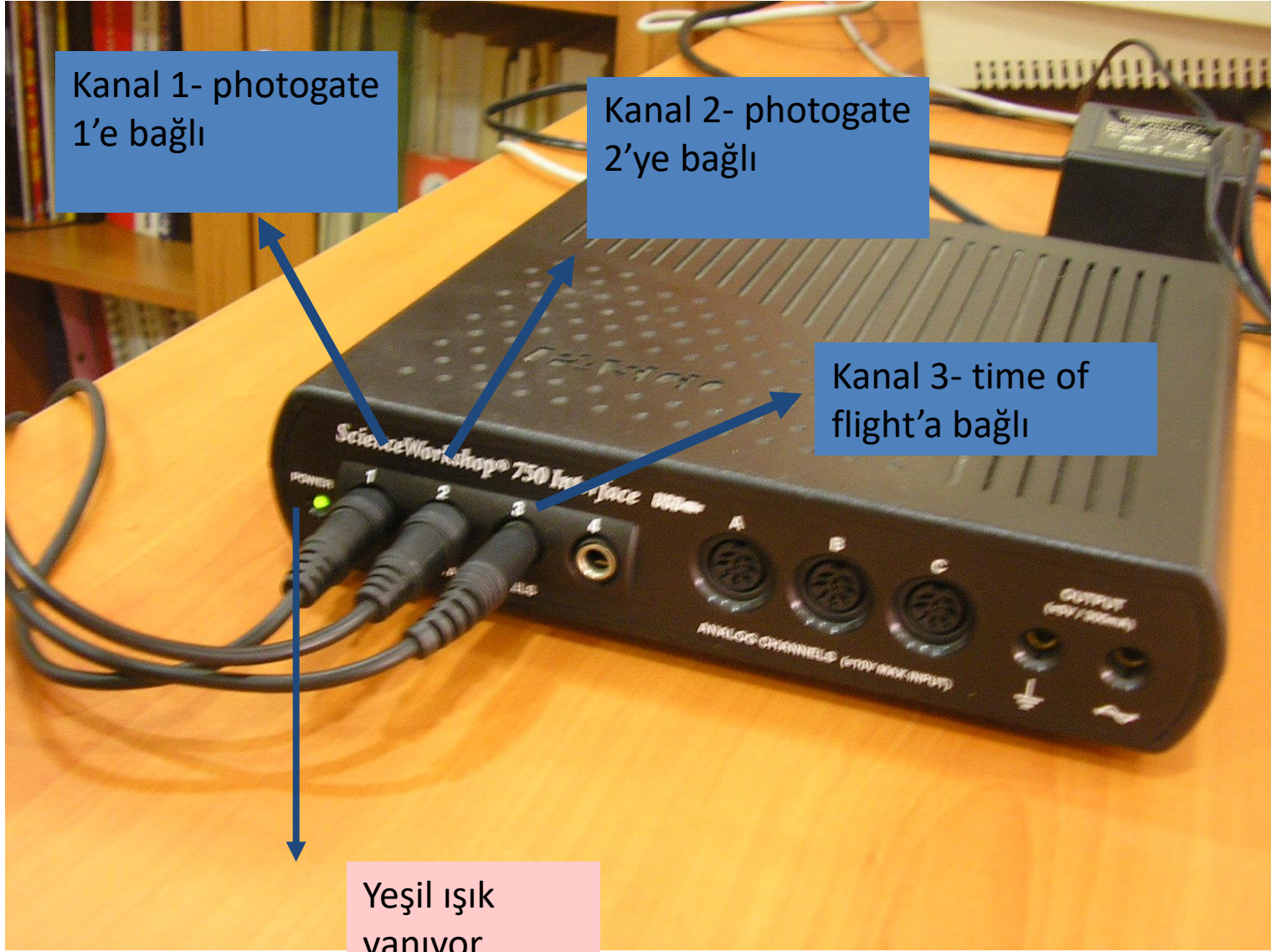
Photogate 2 –
channel two



Photogate 1

Photogate 2

- Attach the photogate mounting bracket to the Launcher and attach two photogates to the bracket. Check that the distance between the photogates is 0.10 m (10 cm).



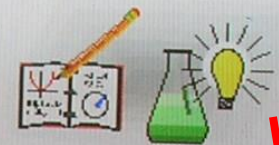
Welcome to DataStudio



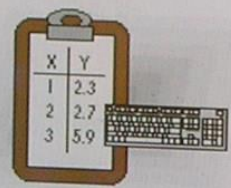
How would you like to use DataStudio?



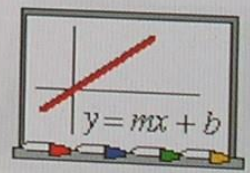
Open Activity



Create Experiment

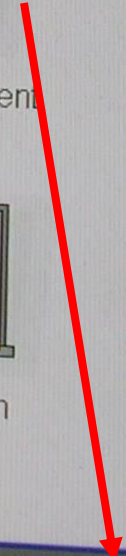


Enter Data



Graph Equation

Show each time this program starts.



Click «create experiment»