Catapults, Projectiles, & Parabolic Flight (part 2)

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Galileo's Study of Projectiles

$D = 1/2(a)(t^2)$

- We have explored velocity, launch angles and range. What did you realize?
- Galileo showed 2 independent motions influence projectiles: horizontal and **vertical** motion.
- Speed of a falling body is independent of it's weight.
- The nature of the motion of a falling object is always the same. Thus, an arrow shot horizontally from a bow falls as the same rate as one that is dropped from the same height.

Projectiles Principles

- What principle of projectiles / falling objects was displayed in this video?
- Discuss the horizontal and vertical motion of each bullet.
- If you were to graph the motion of each bullet, what would they look like?

An example in the NFL

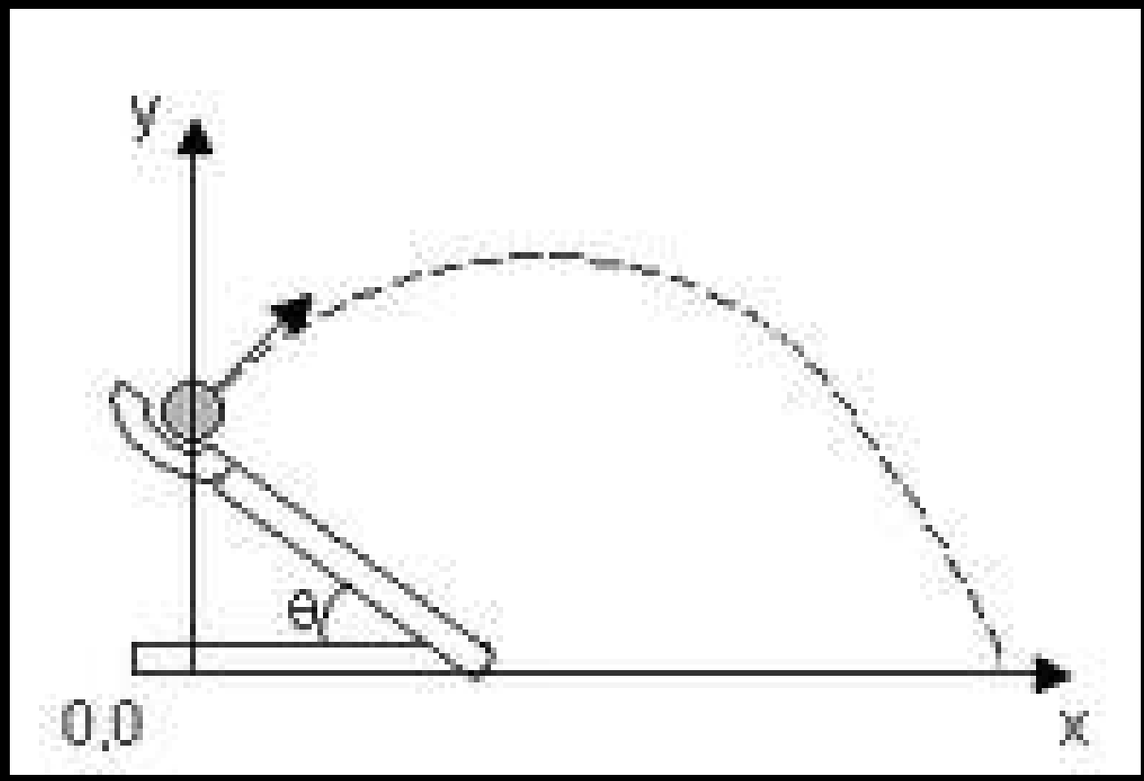
NFL Punters & Parabolic Flight (link)

- What are the 2 main velocities that affect the flight of a punt?
- What is a vector?
- Describe the vertical velocity. When is it positive, negative, and zero?
- Why do you think the nose of the football should face forward when punting?

Catapult Challenge: Part 2

Distance, Time, and Free-fall

- Make teams of 4 students
- Teams will launch ping-pong balls, working to figure out the full trajectory of flight
- This round, you will be timing each launch from the time it leaves until it hits the ground. (Complete handout #2) and graph your trajectory.



Height, Time & Distance

- This formula represents the relationship between distance (height), time and acceleration (due to gravity for a free-falling object):
- **$D = 1/2\ (a) * (t^2)$**

- D = Maximum Vertical Distance (height)
- 1/2 because it takes 1/2 the time to reach vertex
- T = Time (seconds)
- a = 9.81 m/s^2 (acceleration of gravity)

Connections - Seaperch: Underwater Robotics Competition

To perform a task, you need to know how fast the ROV can move in the water in all directions. It’s important to consider the various **forces** that are at work.

This is important to estimate the amount of time required to power the vehicle under water and to determine how quickly you could arrive at your target location.

Connections - Seaperch: Underwater Robotics Competition

Connections Question: If your Seaperch is negatively buoyant, and it takes 9 seconds for it to hit the sea floor (6 meters down), what is the force pulling down your Seaperch?

$$D = \frac{1}{2}(a) * (t^2)$$

Vocabulary

Projectile Motion
Parabolic Flight
Trajectory
Vertex
Range
Axis of Symmetry
Launch Angle
Velocity
Acceleration of
Gravity
Vectors

Sponsors

ASNE - Delaware Valley Section
The American Society of Naval Engineers

L3 communications
SPD Electrical Systems

AUVSI foundation
Association for Unmanned Vehicle Systems International

The Society of Naval Architects & Marine Engineers
Philadelphia

NDEP
National Defense Education Program
Building American Strength in Science and Engineering

Department of the Navy
USN
ONR
Science & Technology

Drexel University College of Engineering

Delaware Valley Chapter
NDIA
National Defense Industrial Association

Drexel University

NAVSEA
Warfare Centers
Philadelphia

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