SCIENCE OF NFL FOOTBALL: Punting and Projectile Motion (Grades 5-8)

After a short intro activity in which students throw various objects into buckets, the class will watch "The Science of NFL Football: Projectile Motion and Parabolas." Students will then use a computer simulation program to investigate the variables that affect a projectile's range and time in the air. Finally, students will apply what they learn from the simulations to analyze punting strategies in different situations.

Introduction Notes:

SCIENCE OF NFL FOOTBALL
Punting and Projectile Motion (Grades 5-8)
STEM Lesson Plan
Lesson plans produced by Lessonopoly (lessonopoly.org)
Video produced by NBC Learn in partnership with the NFL and the National Science Foundation

SPECIFIC OBJECTIVES:

Students will be able to: use a computer simulation to investigate how certain variables influence the range of a projectile (angle, initial velocity, air resistance, mass, shape); explain why increasing the initial velocity will increase the range a projectile travels; identify that the angle for maximum range is 45 degrees if there is no air drag; express that for a given initial velocity, there are 2 angles that will produce the same range, and that for the larger angle, the object will be in the air longer; describe how a punter might use concepts of projectile motion in different situations (for example, at times it is preferable to maximize hang time, while other times it is preferable to maximize distance).

REQUIRED MATERIALS

Science of NFL Football video: "Punting and Projectile Motion"; Some targets for introductory investigation (garbage cans, buckets, or boxes); assorted materials for students to attempt tossing into targets (paper, cotton, tennis balls, feathers, pencils, specks of sand, drinking straws….anything); computers for individuals (or groups of 2-3 students); internet access.

ANTICIPATORY SET (LEAD-IN)

Inform the students that the upcoming lesson will be a fun activity related to the physics of football, but that the introductory activity will have more resemblance to basketball. Ask the students to briefly discuss what basketball, baseball, football, shot put, tennis, golf, volleyball, and soccer all have in common. Introduce the term "projectile" and agree upon a working definition (an object thrown, kicked, hit, or launched through the air). Let students know that the laws of physics for projectile motion are the same for all sports, and in fact the same laws are used to help design skate-park ramps, certain weapons, and satellites.

Watch the NBC Learn Science of NFL Football video: “Projectile Motion and Parabolas.”

https://www.youtube.com/watch?v=HB4ws7RoA3M

ACTIVITY WORKSHEET: Punting And Projectile Motion

Name: _____ Date: _____

Part 1

Define the following terms:

Projectile

Initial Speed

Launch Angle

Range

Air Resistance

Drag Coefficient

What objects were particularly difficult to toss into the target? Why?

Use a drawing to describe the paths (trajectories) of different objects.

Part II

Go to the PHET web site http://phet.colorado.edu/web-pages/simulations-base.html. Go to the Physics Page and scroll down to select the Projectile Motion simulation. Spend a few minutes familiarizing yourself with the simulation.

1. Air Resistance (Drag Coefficient) vs. Range: Create and conduct an investigation to determine how air resistance (drag coefficient) affects the range of a projectile.

Briefly describe the technique you will use. What variable(s) will you change and what variable(s) will you measure?

Make a table to record your results.

Reflect upon your data table and explain what you found about the effect of air resistance (drag coefficient) on the range of a projectile.

2. Initial Speed vs. Range: Create and conduct an investigation to determine how initial speed affects the range of a projectile.

Briefly describe the technique you will use. What variable(s) will you change and what variable(s) will you measure?

Make a table to record your results.

Reflect upon your data table and explain what you found about the effect of initial speed on the range of a projectile.

3. **Launch Angle vs. Range:** Create and conduct an investigation to determine how the launch angle affects the range of a projectile. (Note: You are encouraged to try many angles between 0° and 90°.)

Briefly describe the technique you will use. What variable(s) will you change and what variable(s) will you measure?

Make a table to record your results.

Reflect upon your data table and explain what you found about the effect of launch angle on the range of a projectile.

4. With **no air resistance**:

Find the angle that will produce the maximum range and record this angle:

Is this angle different for different objects?

5. With **Air Resistance**:

Find the angle that will produce the maximum range and record this angle:

Is this angle different for different objects?

6. For a football, find 2 different angles that produce the same range.

Record these two angles and the range:

Compare the time in the air for each of these angles, and explain any difference.

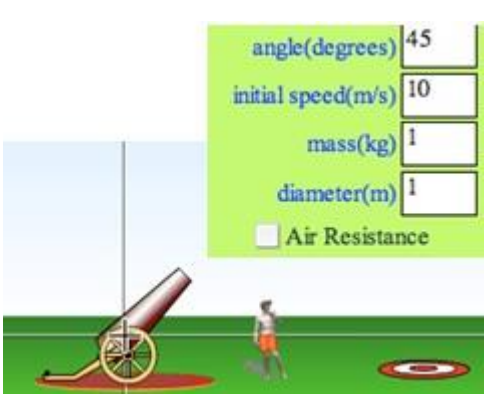
7. What advice about angle and kicking speed would you give to a punter who wants to maximize the distance of a punt? Why?

8. What advice about angle and speed, would you give a punter that is ***not*** trying to maximize distance, but instead wants a long “hang time” to allow his teammates as much time as possible to “get downfield”.

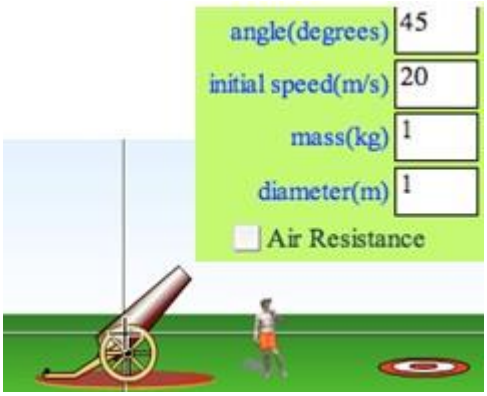
QUIZ: Punting and Projectile Motion

Name: _____ Date: _____

A. Slower Initial Speed



B. Faster Initial Speed



1. In the above pictures, which football will travel the farthest?

A .The one with slower initial speed

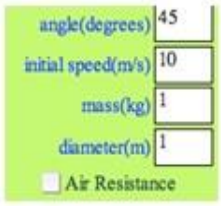
B. The one with faster initial speed

C. They will travel the same distance

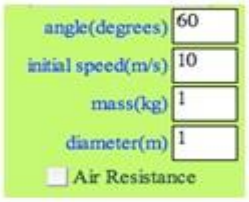
1b. Explain your answer:

A. 30 degree

B. 45 degree



C. 60 degree



2. In the above pictures, which football will travel the farthest?

A. The ball launched at 30 degrees

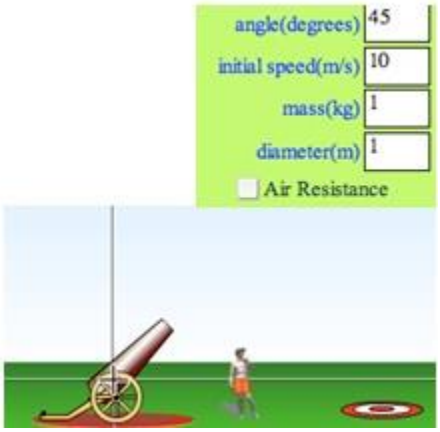
B. The ball launched at 45 degrees

C. The ball launched at 60 degrees

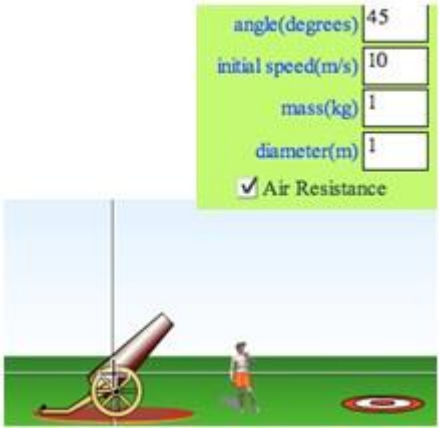
D. They will all travel the same distance

2b. Explain your answer:

A. No Air Resistance



B. With Air Resistance



3. In the above pictures, which football will travel the farthest?

A. The one with no air resistance

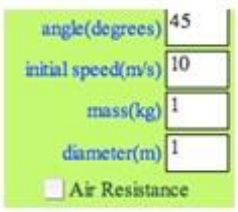
B. The one with air resistance

C. They will travel the same distance

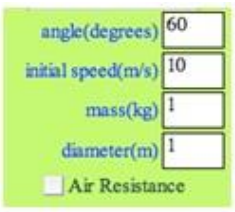
3b. Explain your answer.

A. 30 degree

B. 45 degree



C. 60 degree



4. In the above pictures, which football will stay in the air the longest?

A. The ball launched at 30 degrees

B. The ball launched at 45 degrees

C. The ball launched at 60 degrees

D. They will all stay in the air the same time.

E. A and C will both stay in the air longer than B.

4b. Explain your answer:

If a football is kicked with a constant speed and air resistance, is it possible for 2 different angles to produce the same range? Explain.