



## Classroom Teacher Preparation

### Physics 6: Ballistics

Please use the following to prepare for the next SfS lesson.

#### Description:

This module is a qualitative introduction to projectile motion. Students first independently compare the paths followed by objects simply dropped from a height (that is, having zero horizontal velocity) with those of objects pushed off an elevated surface (with nonzero horizontal velocity). Student observations are used as a segue into an explanation of velocity as a quantity that has both size and direction, and which can be understood in terms of its horizontal and vertical components. The lesson concludes with an activity testing the horizontal range of a projectile as a function of its launch angle. Students will make a graph of the range vs. launch angle and will discover the angle at which a projectile travels the furthest horizontal distance after launching. This lesson is aimed at older (7<sup>th</sup>-8<sup>th</sup> grade) students.

#### Lesson Objectives – SWBAT (“Students Will Be Able To...”):

7<sup>th</sup>-8<sup>th</sup>

- Explain that an object in motion changes speed only when acted upon by an outside force
- Understand that the vertical component of velocity determines the time of flight for a projectile
- Understand that the range of a projectile depends upon the time of flight and the horizontal component of its velocity

#### Disciplinary Core Idea (DCI)

PS2 Motion and Stability: Forces and Interactions – PS2.A Forces and Motion

- (6<sup>th</sup>-8<sup>th</sup>) The role of the mass of an object must be qualitatively accounted for in any change of motion due to the application of a force.

#### Science & Engineering Practice (SEP)

Analyzing and Interpreting Data

#### Preparation:

Students should understand that a **force** is a push or a pull on an object, which causes it to change speed and/or direction. **Gravity** is the force that pulls objects towards the earth.

#### Room Set Up for Activities:

Students will need room to work in pairs at their desks dropping and pushing hacky sacks from desk height. For the main activity, the instructors will need to be able to clamp two projectile launchers to tables or desks at either end of the room. The launchers require a clear area in front of them with a radius of about 1.5 m. The class will be split into two teams, and each team will be split into three groups. Each team will be matched with an instructor who will demonstrate how to use the projectile launcher, and then the smaller student groups will each be assigned a launch angle to test.

#### Safety:

During the launches, the sub-groups using the launcher must wear safety goggles.



## Related Modules:

This lesson may be taught as part of a sequence or group of related modules on **Physics**, particularly **Motion**. Other modules in this sequence include:

*Physics 5: Pendulums* - Students are introduced to pendulums and their periodic motion. They design and execute an experiment to determine whether bob mass, chain length, or displacement angle affect the period of a pendulum.

*Physics 4: Gravity* - This exploration-driven lesson uses an interactive physical model of a gravity well to introduce students to the laws governing the gravitational interactions of objects.

*Physics 19: Friction* - This lesson provides students with an introduction to the concept of friction and a chance to discover two types of friction. Students explore the differences in frictional forces for different materials through experimentation.

For other module sequences and groups, look here: [www.sciencefromscientists.org/sequences](http://www.sciencefromscientists.org/sequences)

## Standards Covered:

Please click the following link to our website to review the standards covered by this lesson, listed by state:

<http://www.sciencefromscientists.org/standards/>

Lessons are matched to both national NGSS and local state standards.

## After Our Visit:

*Extend this lesson by constructing and testing a miniature marshmallow catapult for variables such as lever arm length and the weight of the launched object.*

Access this Extension activity by visiting the Classroom Post found on our website at [sciencefromscientists.org/cohorts](http://sciencefromscientists.org/cohorts). Use the name of your school/cohort and password to log in.

To help Evaluate, check out our Open Response questions online at [sciencefromscientists.org/open-response-questions](http://sciencefromscientists.org/open-response-questions). They are freely available for all of our lessons for current teachers. Use the password supplied by your instructor to log in.

## Additional Resources:

**WGBH Videos and Activities:** The PBS educational site is a great, **free** resource for educators but you must create an account to use the materials. The first time you log in to the [PBS Learning Media](http://PBS Learning Media) website you will be asked to create an account and provide an email and password. Once you have logged in, select “keep me logged in” to avoid having to repeat the process.

- Projectile Motion Simulation: <http://mass.pbslearningmedia.org/resource/hew06.sci.phys.maf.projmotion/projectile-motion/>
- Laws of motion in amusement park rides: <http://mass.pbslearningmedia.org/resource/idptv11.sci.phys.maf.d4kfom/force-and-motion/>
- They Might Be Giants music video, “Speed and Velocity”: <https://www.youtube.com/watch?v=DRb5PSxJerM>