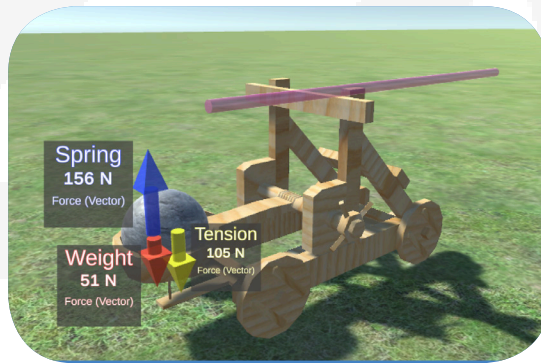


1.1

Control the Force Used to Launch a Cannonball

Steps:



The catapult you will be working with

Step 1: Download the asset package and set up your screen [10 min]

Step 2: Open lesson 1 and experiment with Force variables [10 min]

Step 3: Calculate your cannonball's acceleration [10 min]

Step 4: Open Target Free Play and use variable forces to hit the target [10 min]

Lesson Length:

60 Minutes

Overview:

You will begin the project by opening the Unity editor and downloading the project assets by following the included link. When you have the assets loaded and configured, you will start lesson one and begin working through the included steps. By changing the sliders that control your cannonball's mass and the spring force of your catapult, you will watch how the forces applied by a catapult affect the arc and speed of a projectile. Using the dataset you collect from the launch; you will calculate the acceleration of your cannonball. Once you are finished with the lesson activity, you will move on to the target free play section and experiment with mass and force until you are able to hit the center of a target.

Project Outcome:

The player will be able to explain the relationship between the forces applied to a cannonball, the mass of the ball, and the ball's acceleration. Using what they've learned, they will find the optimal mass and force settings needed to hit the bullseye on a target.

Learning Objectives:

By the end of this lesson, you will be able to:

- Adjust the mass of the cannonball being launched from a catapult.
- Adjust the force applied to a cannonball by a catapult.
- Understand the relationship between a force applied to a cannonball and its velocity.

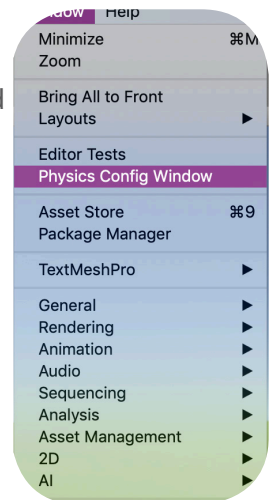
- Understand the relationship between a force applied to a cannonball and the distance it travels.
- Use the velocity calculated in the Unity editor to determine the acceleration of a cannonball at different points in its arc.

Note: Use the equations provided on the Formulas and More page to help you calculate the acceleration of your cannonball.

Step 1: Download the Assets Package

The first thing we need to do is download the assets package and open it in Unity:

1. Scroll up to the Overview section of this page, locate the *Tutorial Materials* and click on the link labeled "CatapultPhysics.zip". Download the file and save it somewhere where it will be easy to find, like on the desktop.
2. At this point, you'll need to unzip the file. If you don't know how to do that, check below these steps for more information.
3. Open Unity by double-clicking the icon. Once you have the Unity launcher open, click *New* in the top right corner of the dialog box. Then click *Create project*.
4. Once Unity has loaded you should see a blue and gray *Game* window on your screen. From the *Assets* drop-down menu at the top of the screen, select *Import Package* and then click *Custom Package*.
5. Browse your computer for the unzipped file, select it, and click *Open*. Then click *Import*. Once it loads, in the top right corner, you should see a tab named *Project*. If you do not see that tab, you can find it in the *Window* drop-down menu under *General*-> *Project*.
6. Under the *Project* tab, locate *Assets*-> *Scenes*. Click *Scenes*. Then double-click the icon to the right labeled *PhysicsCatapult*.
7. You should now see a catapult. Also from the *Window* tab at the top of the screen, select *Physics Config Window*.
8. Click on the tab at the top of the *EditorPhysicsConfig* window to drag it to the right-hand side of the screen and dock it.
9. Close any other tabs shown on the right-hand side of the screen.
10. Before you begin, make sure you have the *Game* window and *EditorPhysicsConfig* window

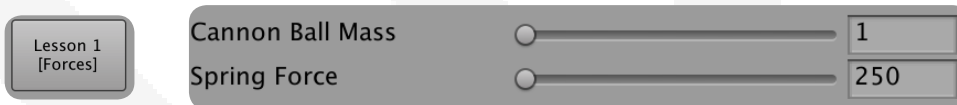


Note: You can unzip a .zip file by right-clicking the icon and selecting *Extract All*. If you already see the catapult on your screen, skip to #7.

Step 2: Open Lesson 1 and experiment with Force variables

Use the Cannonball Mass and Spring Force sliders to adjust your catapult's settings:

1. Click on the *Lesson 1* button and then the *Proceed to Step 1* button.
2. Using the two available sliders, configure the settings for your catapult.
3. Click *Proceed to Step 2* and watch how the selections you made using the *mass* and *force* sliders affect the way your cannonball is launched.
4. Click *Proceed to Step 3* and record the velocity of your cannonball at the height of its arc.

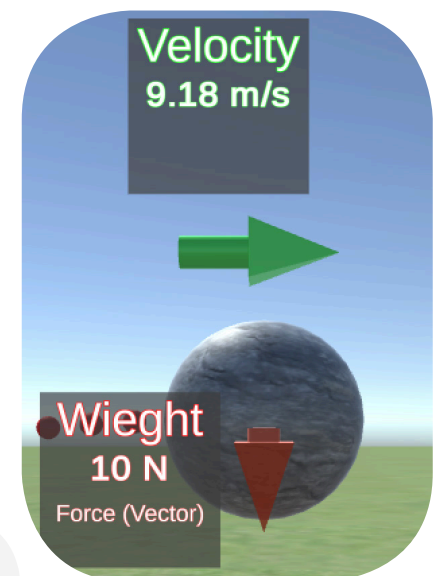


Step 3: Calculate your cannonball's acceleration

Pick two sets of values for your cannonball mass and spring force:

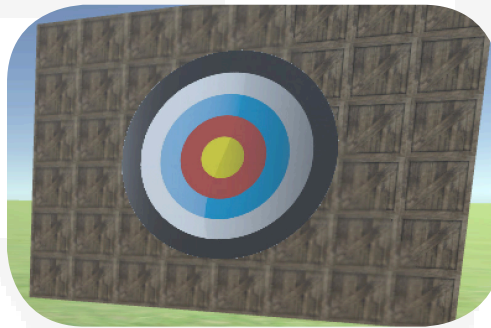
1. Click the button for *Lesson 1* and pick a setting for your *mass* and *spring force* and proceed through the three steps.
2. Record your cannonball's velocity at each stage in the launch process.
3. Using the velocity data points you've recorded, calculate the acceleration of your ball from prelaunch to the height of its arc.
4. Using the velocity datapoints you've recorded, calculate the acceleration of your ball from the height of its arc to when it settles on the ground.

Note: If you don't know how to calculate the cannonball's acceleration, don't worry! All the formulas you need to calculate acceleration can be found on the Formulas and More page.



Step 4: Open Target Free Play and use variable forces to hit the target

1. Click on the *Free Play [Target]* button.
2. Try and hit each of the colored rings on target by changing the mass of your cannonball and your catapult's spring force; start with the black ring.
3. When you've hit each of the colored rings on the target, try and hit the bullseye at the target's center.
4. Once you've found a set of mass and spring force values that allow you to hit the center of the target, find a way to hit the center of the target with the mass set to its lowest and highest values.



End of Lesson

Recap Key Concepts :

- Force, mass, and acceleration

Key Skills

- Using sliders in Unity to manipulate mass and force variables
- Using datapoints collected from Unity to calculate acceleration
- Understanding the relationship between force and mass and applying the knowledge to hit target positions

Extension Challenge ideas:

- Explain how Newton's three laws of motion apply to the catapult through each stages of the cannonball's launch
- Explain the difference between the Spring Force vector and the Resultant Force vector in the second step of the cannonball's launch
- Using Hook's Law, calculate the amount of extension of the catapult's spring based on the Spring Force value when the cannonball launches at the end of step 2