PROJECTILE LAUNCHER
ADVANCED BUILD GUIDE

Start by building the example launcher, then turn it into ***your own*** unique design.

STEM TRUE STEAM

You Are Here

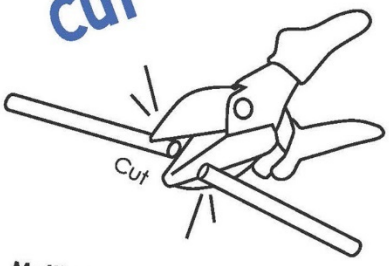
GO → Build Guide → Lab Activity Optional → Launching & Graphing Sheet → Design & Engineering Challenge

Download documents at **teachergeek.com/learn**

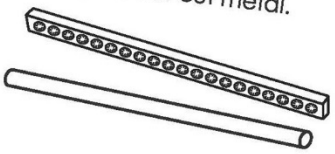
For use with TeacherGeek Projectile Launcher Activity, or Maker Cart available at **teachergeek.com**.

PROJECTILE LAUNCHER ADVANCED BUILD GUIDE

Cut



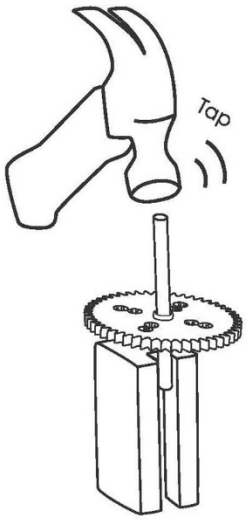
Multi-Cutters cut wood & plastic (like **dowels** and **connector strips**). They do not cut metal.



Push, Wiggle,

Push, wiggle or tap **dowels** into holes.

Tap



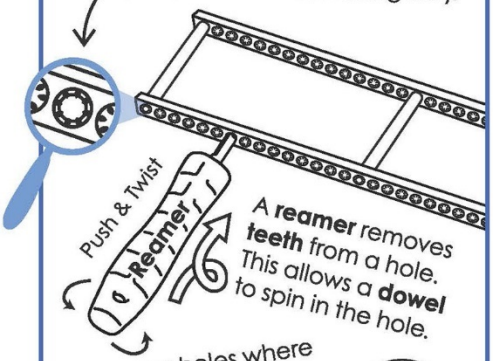
Use a **hammer** and **slider block** to tap **dowels** farther through holes.

Quick Tip!

Use a crayon, or soap on the end of a Dowel to make building easier.

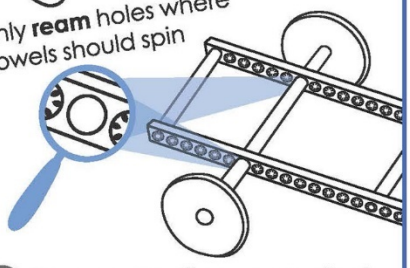
Ream

Most parts have holes with **teeth**. The **teeth** hold **dowels** (keep dowels from falling out).



A **reamer** removes **teeth** from a hole. This allows a **dowel** to spin in the hole.

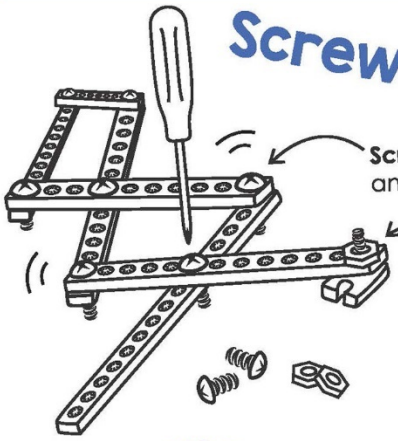
Only **ream** holes where dowels should spin



Never **ream pulleys, gears, wheels,** or any hole a **dowel** stays stuck into.

Screws & Nuts

Do not **ream** holes you will put **screws** into.

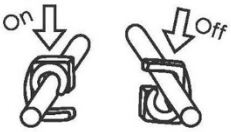


Screws (without nuts) can connect parts, and allow them to rotate.

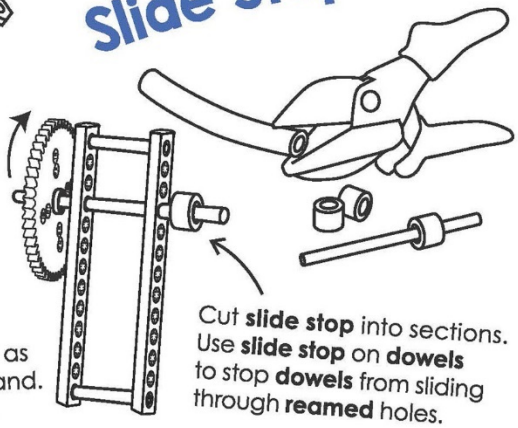
Screws (with a nut) can connect parts, and keep them from rotating.

Slide Stop

Stop Clip



Press a **stop clip** onto a **dowel** to keep it from sliding or use it as a hook for a string / rubber band. It takes little force to get it on.

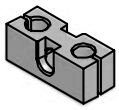


Cut **slide stop** into sections. Use **slide stop** on **dowels** to stop **dowels** from sliding through **reamed** holes.

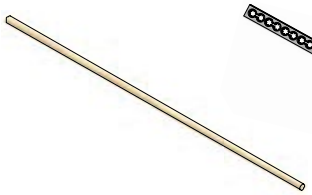
TeacherGeek Components

For One Launcher

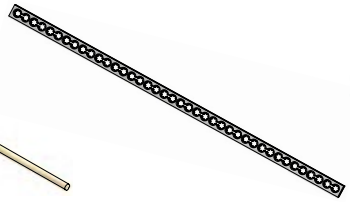
Here are TeacherGeek components to make the example projectile launcher, and then turn it into your own unique design.



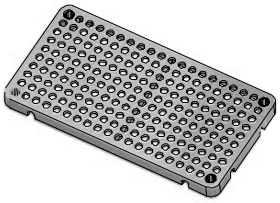
8 - Blocks



6 - Dowels
30cm (12")



4 - Connector Strips



2 - Hole Plate

1 - Ping Pong Ball

12 - Nuts
#10

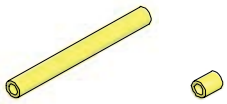
2 - Lock Nuts
#10

2 - 38mm Screw
38mm (1½") #10

10 - 25mm Screw
(1") #10

8 - Rubber Bands

4 - Stop Clips

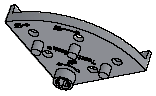


1 - Slide Stop
76mm (3")

1 - Steel Wire
7.5cm (3")

1 - Plastic Coated Wire
8cm (3¼")

You might need to cut this from a wire roll.



2 - Angle Brackets

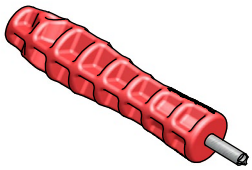
▶ Components available in the TeacherGeek Ping Pong Launcher Activity, TeacherGeek Maker Cart, or at **teachergeek.com**

TeacherGeek Tools You'll Need

Easy to Share in Groups

This isn't a kit. You're going to really build (cut, ream, screw) your launcher. Here are the tools you'll need.

Multi-Cutter
SKU 1823-81



Reamer
SKU 1823-87

Screwdriver
SKU 1823-90

Pliers
SKU 1823-86

Tools available at **teachergeek.com**

Materials You Supply

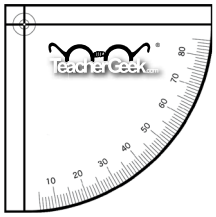
You will need these non-TeacherGeek supplies:

Tape
Masking, Painter's, Duct; Any kind of tape will work.

Safety Goggles
Should be worn during the activity.

Recycling Materials
Add to your design

Scissors
For cutting out the protractor and recycling materials.



TeacherGeek Protractor

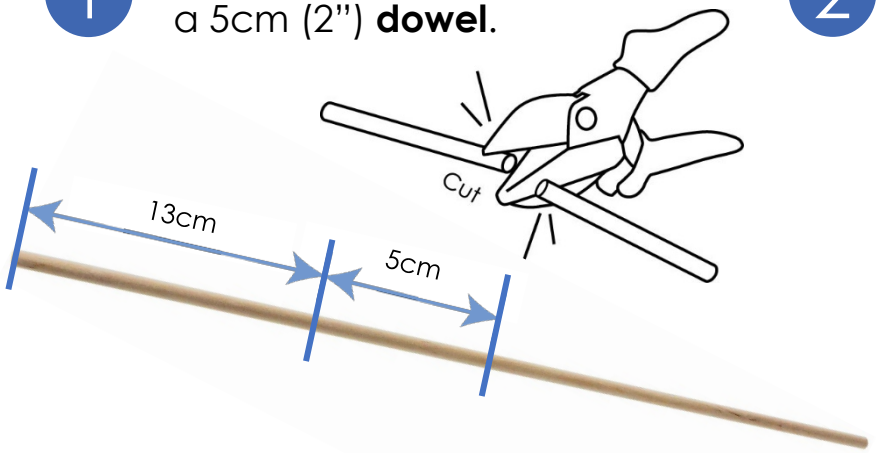
Print on cardstock or thicker paper for a sturdier protractor.

Printable Protractor Download:
http://teachergeek.org/protractor-angle_finder.pdf

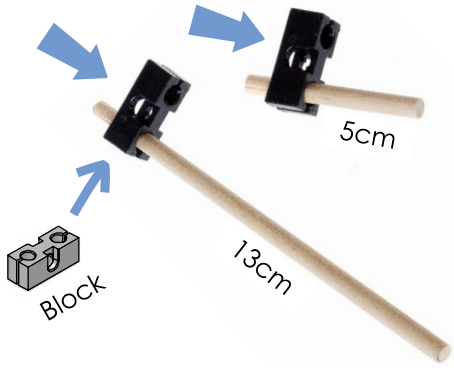
PROJECTILE LAUNCHER ADVANCED BUILD GUIDE

Make the Launch Pad

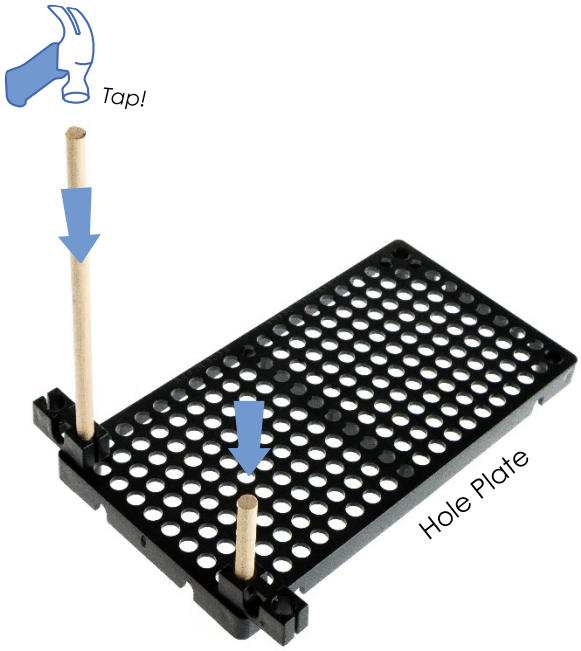
1 **Cut** a 13cm (5") **dowel**, and a 5cm (2") **dowel**.



2 **Push,** or tap, each **dowel** from **Step 1** into a **block** as shown. The dowels should stick out a little.

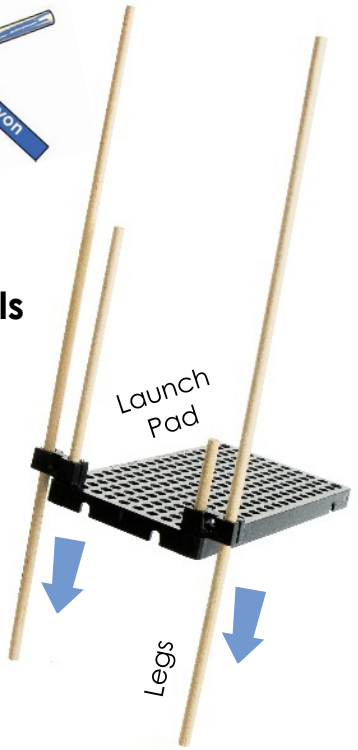


3 **Push** or tap the **dowels** from **Step 2** into the **hole plate,** as shown.



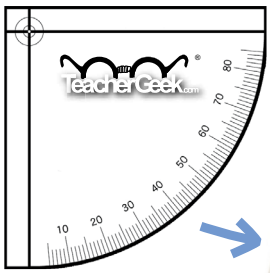
4 **Rub** a crayon, wax, or bar of soap, on two **full** (30cm) **dowels**. This helps the dowels slide.

5 Slide the **dowels** from **Step 4** through the **blocks** from **Step 3**. These will be the **legs.**



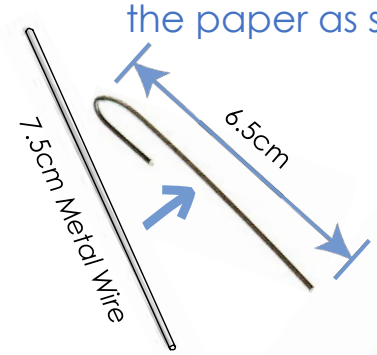
6 Print, cut, and tape a **protractor** to the launcher, as shown.

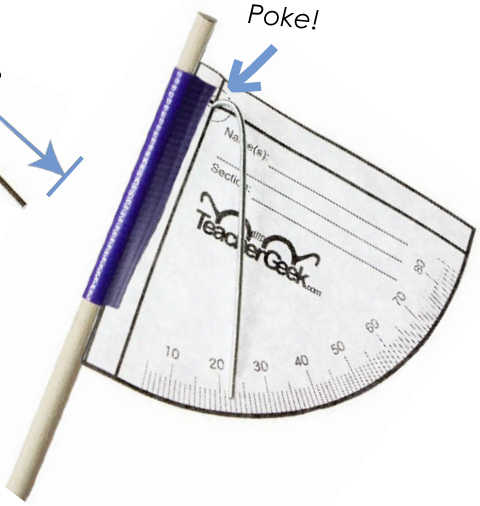
TeacherGeek Protractor

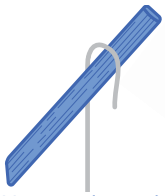


Don't cover the cross-hair (circle) with tape.

7 **Bend** a 1.5cm hook at the end of a 7.5cm **Steel wire** (Not the plastic coated wire). **Poke** it through the **protractor** at the ⌖. Hang it on the paper as shown.



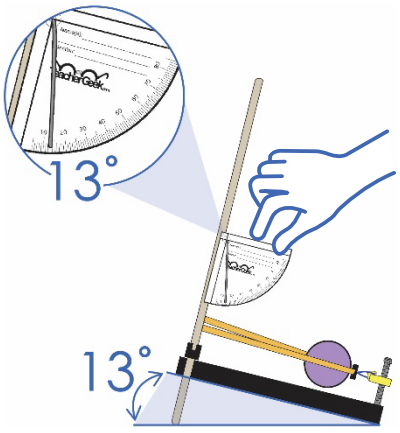




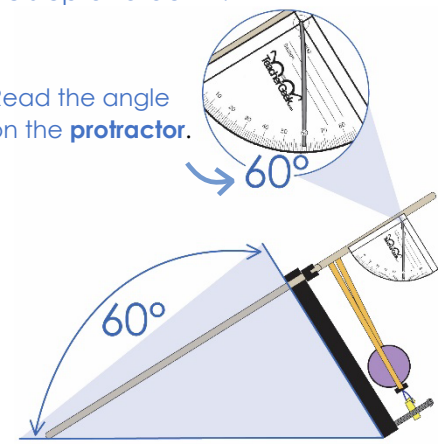
Use a dowel or pencil to bend the hook.

Make sure the metal wire points **straight down** when the protractor is tilted.

Change the angle of the launch pad by sliding the leg dowels up and down.



Read the angle on the **protractor**.



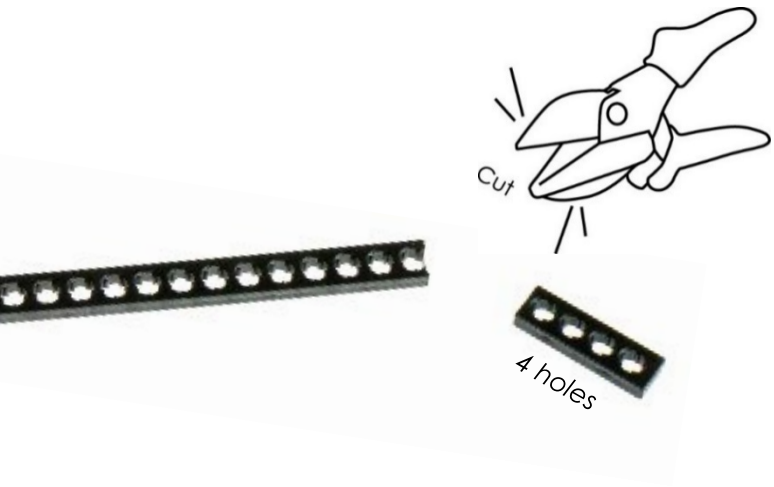
▶ Congratulations!

Your Launch Pad is finished! Now, it's time to create the Launching Mechanism.

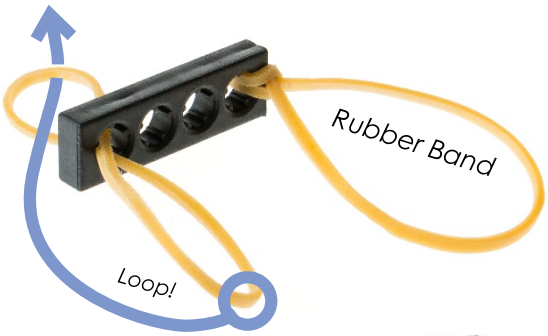
Printable Protractor Available at:
http://teachergeek.org/protractor-angle_finder.pdf

Launch Mechanism

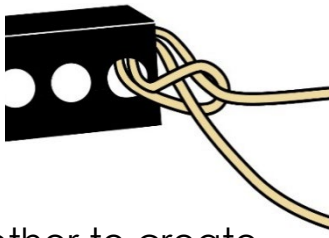
8 **Cut** a piece of **connector strip**, four **holes** long.



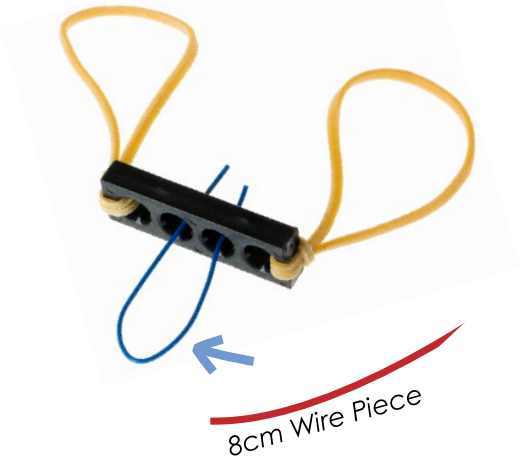
9 **Connect** two **rubber bands** to the cut **connector strip**, as shown.



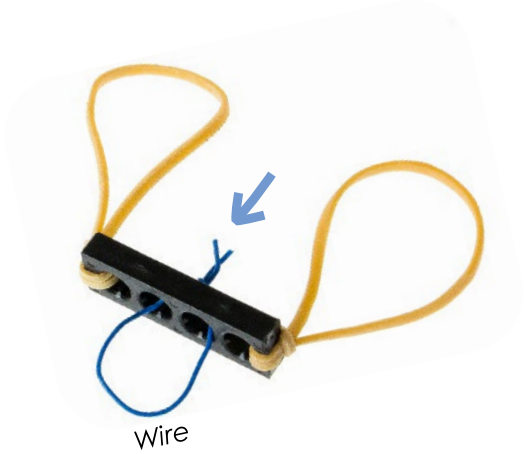
Getting it right can be tricky. Take your time!



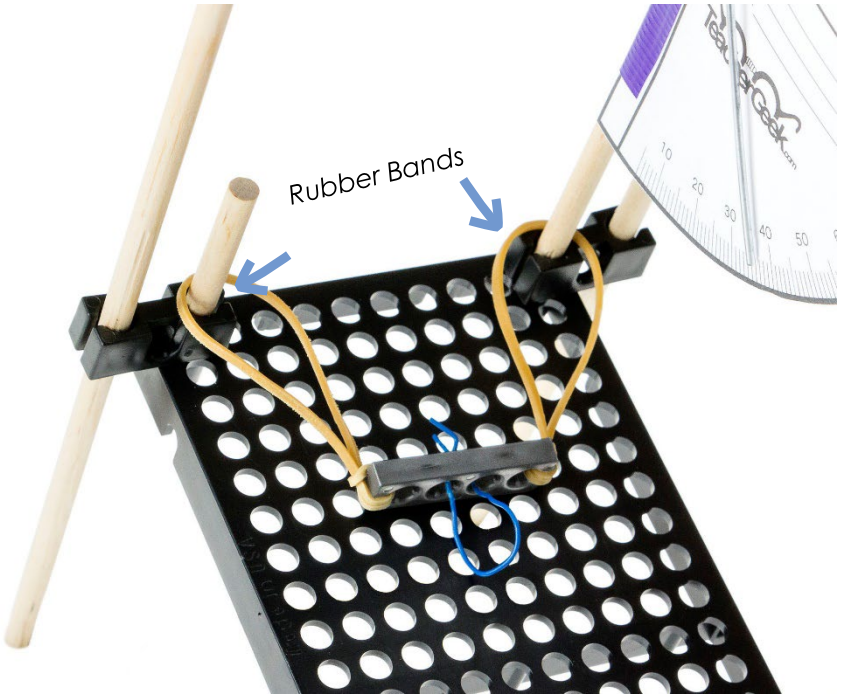
10 **Cut**, or find, a 8cm (3") piece of plastic coated **wire.** Fold it in half and place each end through a **connector strip** hole.



11 Twist **wire** ends together to create a strong **loop**. This will be the launch mechanism.



12 **Slide** the launch mechanism **rubber bands** over the Launch Pad **dowels** shown.

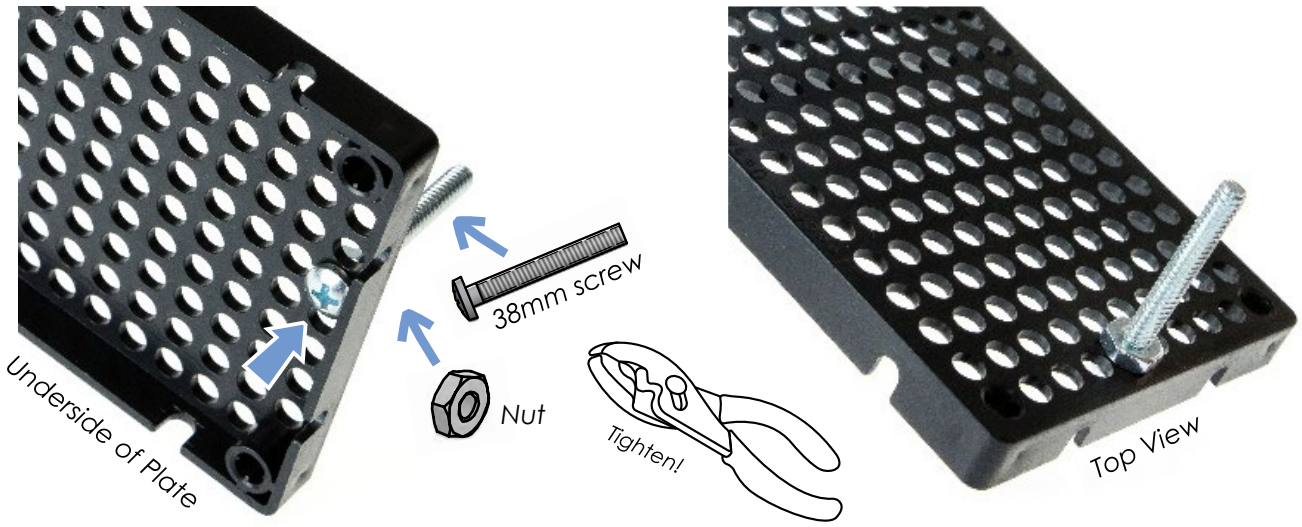


▶ **Give it a try…**
Pull it back, place a ping-pong ball in the launch mechanism, let go and watch it fly.

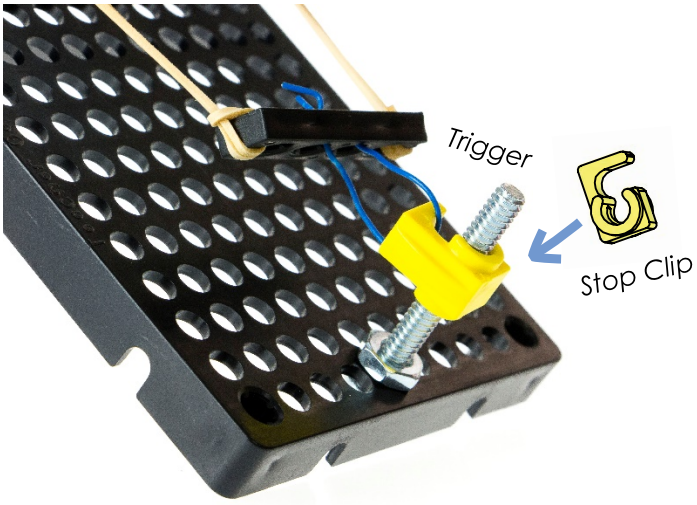
Can you get it to hit the same spot twice? Probably not…
Try building a trigger to help out.

Trigger Build

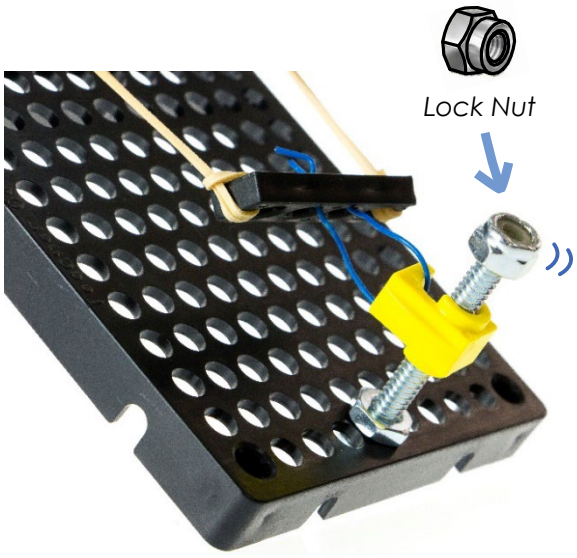
13 Place a **38mm** (1 ½") **screw** through the bottom of the **hole plate**, as shown. **Fasten** it with a **nut**.



14 **Place** a **stop clip** on the **screw** to create a **trigger**.



15 **Place** a **lock nut** on the **screw** to prevent the stop clip from sliding off.



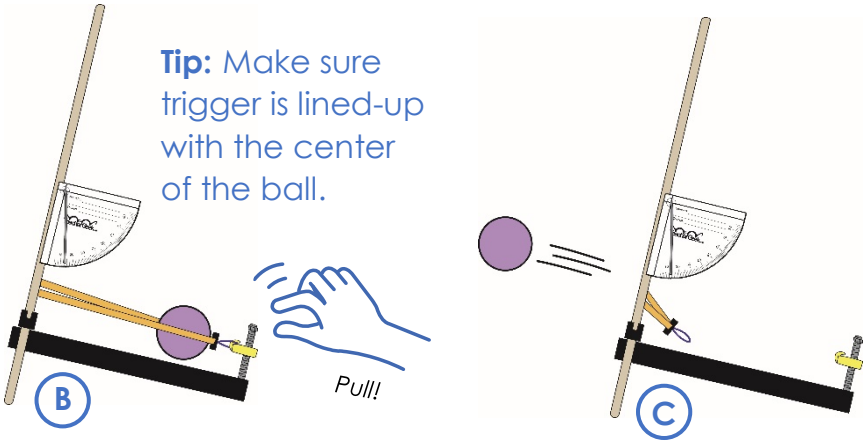
Launching

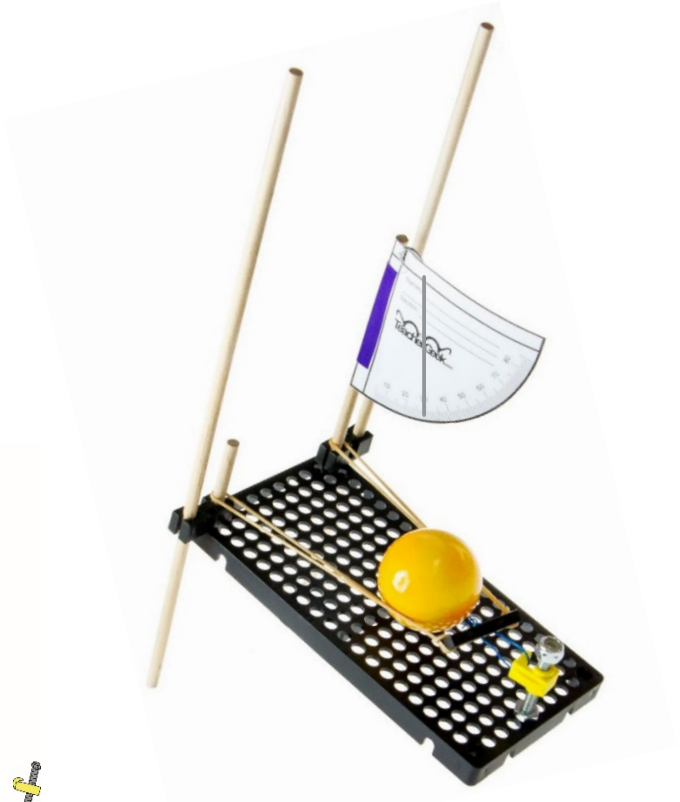
Test Your Launcher Out!

Ⓐ **Pull** back the **launching mechansism** and **attach** it to the **trigger** (stop clip).

Ⓑ **Place** a ping-pong **ball** into the **launch mechanism**.

Ⓒ ***Turn the trigger (stop clip) to fire!***





Caution: Wear safety glasses. *Never* launch at another person.

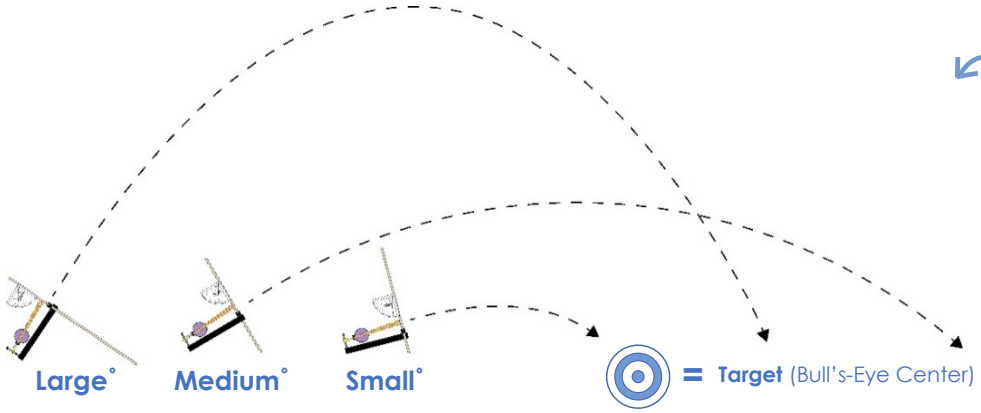
PROJECTILE LAUNCHER ADVANCED BUILD GUIDE

Experiment & Play

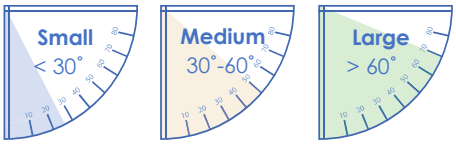
= Projectile

= Trajectory

The **angle** of launch affects the projectile's **trajectory** (how high + far it launches).



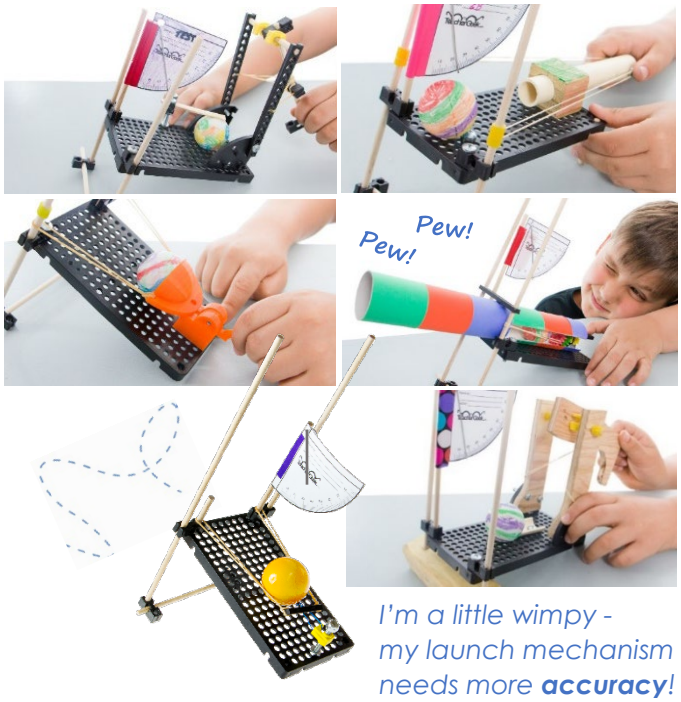
Try It Out: Slide the legs to change the **angle** *of the launcher? How does angle affect the projectile's trajectory?*



Redesigning Your Launcher

The example launcher is just...ok

You can redesign it much better!



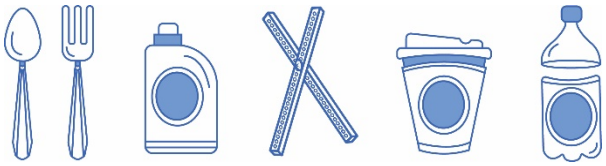
*I'm a little wimpy - my launch mechanism needs more **accuracy**!*

Redesign Your Launcher to Be...

- **Accurate** or how close you get to the ***actual*** (true) target or goal (bull's-eye).

- **Precise** or how ***constant*** (repeatable) the results are (landing in the same spot).

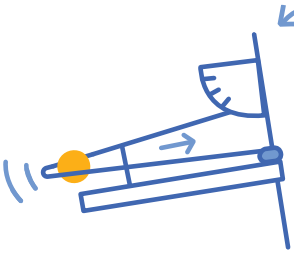
- **Able to Launch Really, Incredibly Far**
  Power adds distance to your shots. Change how much power



Use recycling bin materials, Teachergeek components & 3D printing for your design!

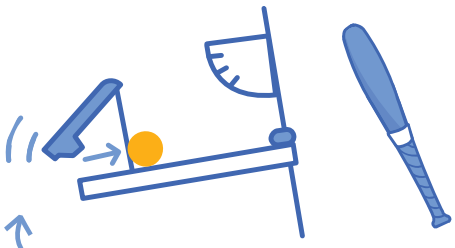
PROJECTILE LAUNCHER ADVANCED BUILD GUIDE

There are many ways to send a ball flying. Here are a few ideas...



Sling It

Pull back and let it go! This is the most popular launch mechanism. The example launcher uses it. You can design your own "better" version.



Toss It

Toss it like a catapult, ballista or trebuchet. Note: It can be difficult to change only one independent variable (see below) with this launch mechanism.

Hit It

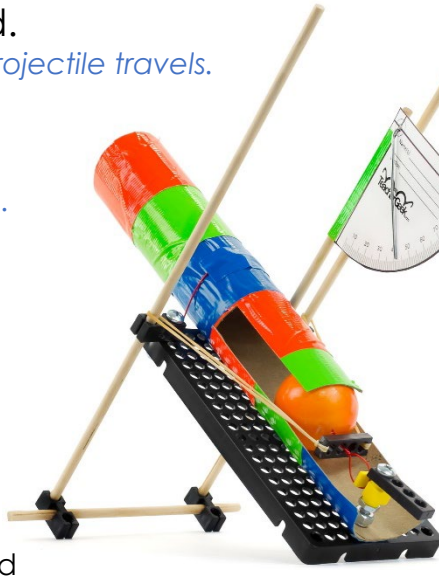
Hit it like a golf ball or baseball. Get the launch mechanism moving before it contacts the ball.

Control Your Variables

Variables: The things that change in an experiment (when you launch a projectile and measure where it goes).
Design and test your launcher so that only the independent and dependent variables change.

Dependent Variable: The variable being tested and measured.
*Only have one dependent variable in your experiment, such as the **distance** projectile travels.*

Independent Variable: The thing you change in the experiment, to test how it effects the dependent variable.
Only have one independent variable in your experiment, such as **launch angle**.



Get Going

What are you waiting for? It's time to start into a lab or engineering challenge. It's going to be a blast!

Visit teachergeek.com/learn to download launcher lab and challenge documents.