

LESSON

# Penny Drop



## Overview



By definition, the outcome of a random event is impossible to know in advance. However, if a random process is repeated often enough, predictable patterns will emerge. This lesson uses a tabletop version of the old carnival game, Penny Drop to explore patterns in repeated random events.

In Penny Drop, a round disk drops through a field filled with closely spaced rows of pegs, navigating a zig-zag path to the bottom. As it encounters each peg, the disk has a 50% possibility of choosing the path to the left or right. By the time the disk has reached the bottom, its final path is an aggregate of many random events – one for each peg it encounters.

This lesson contains design files and instructions to build a Penny Drop board from laser cut acrylic and wood. Screws and pennies constitute the pegs and disks. When each penny drops down the Penny Drop board, its final position is impossible to predict. However, observing multiple pennies falling, it will become apparent that some outcomes are more likely than others..

The crazy zig-zag motion of a penny wending its bottom of the Penny Drop board is fun to watch, and makes the board a good basis for games and challenges. The end of this lesson contains ideas for entertaining activities based on Penny Drop.

### THE OBJECTIVE

Observe a repeated random event (penny falling through a Penny Drop board) to look for patterns in the outcome.

<b>GRADE LEVEL:</b> 3-6 Grade	<b>DIFFICULTY</b> Medium
<b>SUBJECTS</b> Engineering, science, math	<b>DURATION</b> 45 Minutes



### Supplies

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#### MATERIALS & TOOLS:

- 1/8" Wood Sheet
- 1/8" clear acrylic
- One of the following selections to use for pegs:
  - [107x \(15 mm or 16mm\) M3](#)
  - [107 3mm diameter Nylon Snap Rivets capable of binding a 10mm thick panel](#)
- Pennies (a few dozen)



### Description

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#### LESSON OUTLINE:

- Build the Plink Board
- Observe the outcome of repeatedly dropping pennies down the board
- Use the Plink board in activities and games

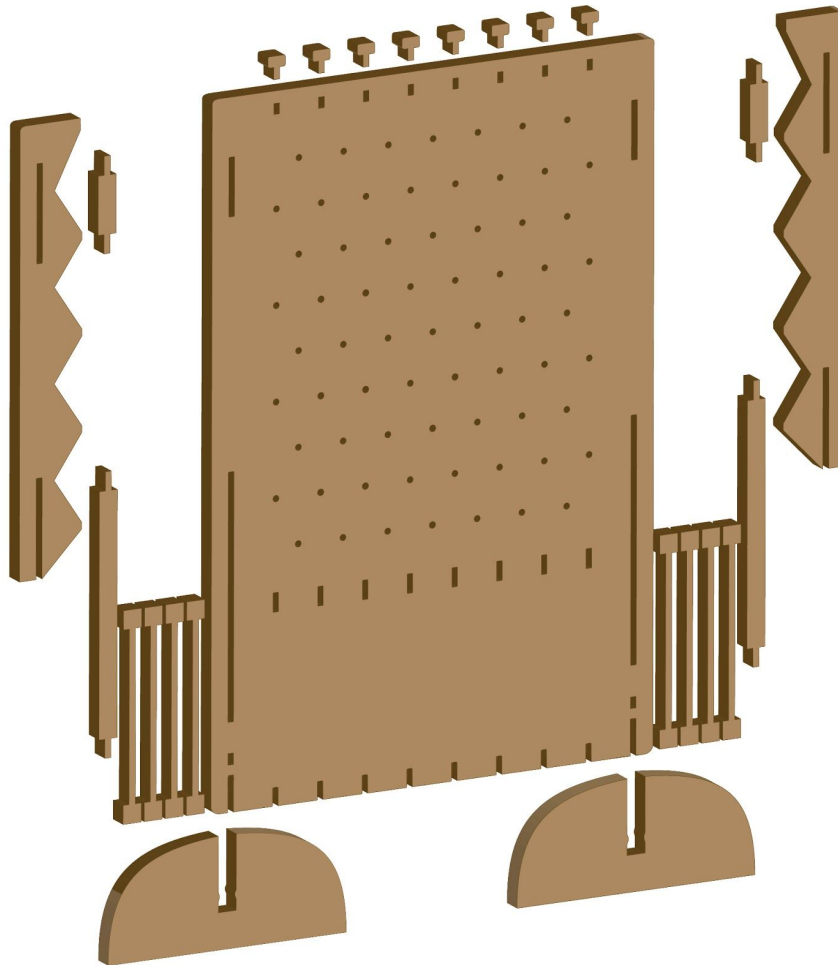


## Lesson Instructions

### Step 1:

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#### Description



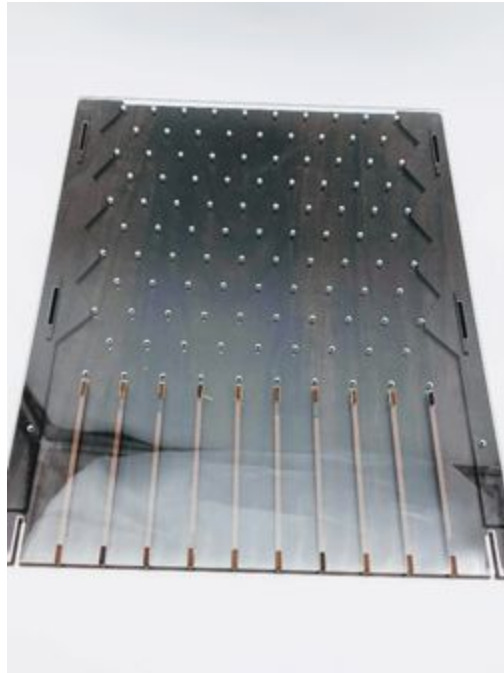
Using the vector files provided, laser cut the wood pieces (“Penny\_DropWoodPieces.pdf”) from 1/8” wood sheet. The wood must be very close to 1/8” (3.2 mm) or the parts will not fit together correctly. Cut the acrylic cover (“Penny\_DropAcrylicPieces.pdf”) from 1/8” clear acrylic. Peel any protective paper off the parts before proceeding.



Lay the wood body piece on a flat surface. Insert the four short pins perpendicular to the base so their edges fit into the slots along the side of the body. Insert the ten long pins into the base as shown above. Each long pin contains “wings” which fit into two slots in the body piece. Each long pin contains one wing in a slot at the bottom edge of the base, and the other wing in a slot several inches above the first.



Take the two guides and place one on each side of the base as shown. The slots in the guides fit over the widest part of the short pins and rest directly on top of the base.



Next, lay the clear acrylic cover on top of the wooden base assembly. Each of the short and long wooden pins will fit into slots in the cover. You may have to wiggle the pins a bit to get them all aligned correctly with the holes in the cover. It is ok to use light pressure on the acrylic to seat each of the pins in their slot, but using too much force risks cracking the acrylic.



Insert the pop rivets (shown above) or M3 screws/acorn nuts through each of the 107 holes between the wooden base and the cover. The acorn nuts will tighten to a fixed position on the screws, which prevents too much force being applied to the acrylic cover. If you use regular screws and nuts, be sure not to over tighten them. The acrylic should not bend anywhere.



Once all fasteners are secured, place the two semi-circular wooden base pieces in the long slots at the base of the Penny Drop board as shown. The base pieces allow the board to stand upright with the bottom opening of the board flush against a flat surface. To remove the pennies from the board, simply lift it off the table, and they will fall out of the bottom. Because pennies are thin, they will form stacks that are two pennies deep when they come to rest.

The base pieces are not attached directly to the board so that they may be removed for storage, but to affix them permanently, apply a bit of wood glue at the joint between the base pieces and the back of the Penny Drop Board.

### Step 2: Explorations

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Ask students to take some pennies and drop them into the slot at the top of the Penny Drop board, observing their motion as they fall. As each “peg” (screw or rivet) along the way down, the penny will move either to the right or the left. Do the pennies seem to fall more in one direction or the other, or do they zig-zag equally to both sides?

Every time the coin hits a screw, it has a 50% chance of moving left and a 50% chance of moving right.

The longer the fall, the further it has a possibility to move.

Thought experiment: What would distribution look like for shortfall:



### Step 3: Evaluate and Test

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Game – give each end slot a number value – try to reach the value without going over in the fewest drops

Random 4 in a row

Game – Use colored markers in different slots? Give each slot a value.