

BUILD A BAND CHALLENGE

The Challenge: Build a four-stringed instrument that can play a tune.

Preparation

- Copy the *Build a Band* handout (one per student).
- Visit pbs.org/designsquad and download the following video clips from the “Teacher’s Guide” page: **Sound Energy** (30 seconds) and **Pitch** (1 minute). Be prepared to project them.
- Gather the materials (per student):
 - duct tape
 - 4 craft sticks
 - shoebox (both lids and boxes can be used to make an instrument)
 - scissors
 - 4 rubber bands
 - 2 pencils (2 medium, 2 thin)

1 Introduce the challenge (10 minutes)

- Have students touch the front of their throats and say something. Ask: How is what you feel related to sound? (*Students will feel their vocal chords vibrate. The vibrations cause sound waves that travel out through the mouth and into the air.*)
- Have them first make a high-pitched and then a low-pitched sound. Ask: How do your vocal chords feel as you change the pitch? (*Vocal chords tighten to produce higher-pitched sounds and relax to produce lower-pitched ones. They also vibrate at a higher frequency for higher pitches.*)
- Show **Sound Energy**. Discuss sound, vibration, and how our ears process sound.
- Ask students to list different kinds of stringed instruments. (*Guitar; ukulele; violin; cello; bass; mandolin; banjo; harp; piano; zither; dulcimer, etc.*) Tell them that today’s challenge is to design and build a four-stringed instrument that can be used to play a tune.
- Who might be interested in a low-cost, low-tech instrument? (*Kids, parents, schools, recreation centers, camps, afterschool programs, people interested in new kinds of sounds. The message is: Music matters, because people love music and there will always be a demand for instruments and sound systems.*)

2 Brainstorm (10 minutes)

Brainstorm sound and pitch

- Remind students that instruments produce the sounds and pitches we call music. Then show the **Pitch** video to explain why we hear faster vibrations as higher pitches.
- What causes different pitches? (*Things vibrating at different frequencies*)
- What can affect a string’s pitch? (*Its length, tension, and gauge*)
- How will a rubber band’s thickness affect its pitch? (*With tension and length equal, a thicker rubber band will produce a lower pitch than a thinner one will.*)
- How is what you did with your vocal chords related to pitch? (*Throat muscles change the vocal chords’ tension and thickness [i.e., gauge], producing different pitches. A vocal chord’s length depends on the size of a person’s throat and changes as a person grows. That’s why adults’ voices are lower than kids’ voices.*)



Students build a four-stringed instrument and investigate how a rubber-band string’s length, thickness, and tension affect pitch.



Students use duct tape to hold the rubber-band strings in place and tune each one to a different pitch.



Students tune their instruments by adjusting the length and tension of the rubber bands.



Finally, students pair up and play a tune together.

Brainstorm the design process

- You can slip rubber bands around a box or cut the rubber bands open, making strips that you tape down. Brainstorm ways to keep a rubber-band strip securely in place. (*Tape down one end. Then drape the other end over the box edge and tape it down so the rubber band pulls against the edge of the box. Students can also pass rubber bands through holes they poke in the box.*)
- Brainstorm ways to keep the box from interfering with how the rubber-band strings vibrate. (*Make a “bridge” by slipping pencils or craft sticks under the strings to raise them off the surface.*)
- Brainstorm some ways to tune a rubber-band string to a different pitch. (*Stretch or loosen it or make it longer or shorter.*)

3 Summarize the problem to solve (5 minutes)

- Break the larger challenge into its sub-challenges. Ask: What are some of the things you’ll need to figure out as you make your instrument? (*What box to use; what side of the box to put the rubber bands on; how to make strings out of rubber bands; how to attach the strings; how to tune the strings; how to make the instrument loud*)
- To promote creative thinking and foster a sense of ownership, have students pair up and brainstorm their own ways of turning these materials into a four-stringed instrument. Distribute the handout and have them sketch their ideas.

4 Build, test, and redesign (25 minutes)

Here are some strategies for dealing with issues that may come up during building:

- **Trouble hearing:** Keep the room as quiet as possible and have students remove anything that interferes with the strings’ vibrations traveling through and then out of the instrument, such as excess tape.
- **Trouble with tuning:** To lower the pitch a little, stretch out the rubber band, making it just slightly longer. Also, raising or lowering the height of the bridge will change the tension and increase or decrease the pitch. Finally, students can adjust a rubber band’s tension by sliding it a tiny bit one way or another across the bridge or box edge. The friction between the edge and the rubber band will hold the rubber band in its new position.
- **Trouble playing a melody:** Remind students that fretting a string, either by pushing it down against the box or by pinching it, will give them different pitches from each string. Have them try: *We Will Rock You*, *Happy Birthday*, or theme songs from TV shows and movies, such as *Pink Panther* or *The Addams Family*.