

Instructions for Constructing Marble Shooter

Chapter 7—Problem 1: An Energetic Ride

The following instructions will help you build a marble shooter for the rollercoaster model described in Chapter 7 of *Problem-Based Learning in the Physical Science Classroom, K–12*. Feel free to modify the design as needed.

Materials:

- ½ inch PVC Pipe (or select a diameter that fits the marbles you will use)
- 3/8 inch wooden dowel rod (diameter selected to fit snugly in the PVC pipe)
- Wooden “button” (axle peg)
- Elastic cord – “round” cord works best.
- Hack saw and/or small hand saw
- Rasp or file
- Electric drill with bits
- Sand paper
- Wood glue or white school glue
- Jumbo clip
- Masking tape

** Most of the materials can be found at your local home improvement or hardware store. The elastic chord is available in the sewing section of most craft stores or department stores.

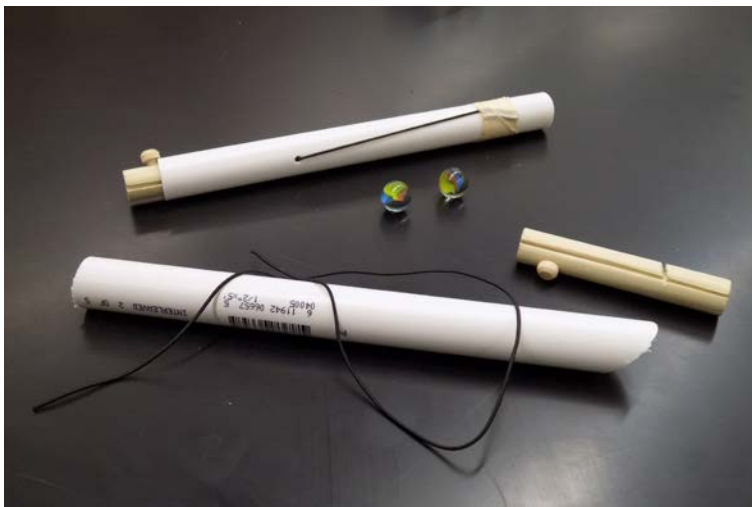


Fig. 1: Marble shooter and parts

Procedure:

1. Cut the PVC pipe to the desired length. The example in the photograph is about 9 inches long. The length can vary, but we recommend you not make the shooter too short. The end can either be cut square or at an angle. The PVC pipe will be the barrel of the shooter.
2. Select one end of the pipe into which the plunger will fit. This will be the “breach” end of the shooter. About 3 inches from the breach end, drill a hole through both walls of the PVC pipe. The hole should pass as close to the center of the pipe as possible. Select a drill bit slightly larger than the diameter of the elastic cord to make it easy to thread the chord through both holes.
3. Cut the wooden dowel to the desired length. The example is about 5 inches long. The dowel will become the plunger in the marble shooter.

4. Test fit the marble and the dowel in the PVC pipe. The marble must pass through the pipe easily. If the fit is too tight, wrap some sand paper around a dowel or pencil and sand the inside of the dowel. It is helpful to sand the openings where you cut the pipe to smooth the rough edges.

The dowel also needs to pass through the pipe easily. If the fit is too tight, sand the entire length of the dowel rod.

5. To leave room for the elastic band to fit inside the pipe with the dowel, make a pair of grooves along the length of the dowel rod. (See figure 2) You can start the groove with the saw, but a file or small rasp works best for creating the groove. Make the groove deep enough for the entire diameter of the elastic band to fit in the groove. Test fit the dowel, and continue to file the groove until the dowel fits smoothly with the elastic cord in the grooves.

6. Use the saw to cut a diagonal slot in the dowel. (See figure 2). The groove should be at least 1.5 inches from one end of the dowel. The slot should reach to the grooves on each side. This slot will hold the elastic cord. Test fit the cord in the slot, and sand until it fits.



Figure 2: Plunger with groove, diagonal slot, and button

7. Drill a hole about $\frac{1}{2}$ inch from the end of the dowel opposite the slot. The diameter of the hole should be about the same as the stem on the wooden “button.” The button will be glued into the hole as a “stop” to prevent the dowel from sliding all the way into the PVC pipe.

When finished, the plunger should look like the example in figure 2.

8. To assemble the shooter, thread the elastic chord through the PVC pipe. (See figure 3) Leave plenty of extra length on both ends of the chord. It may help you thread the cord through the holes if you trim and tape the end to avoid frayed ends.

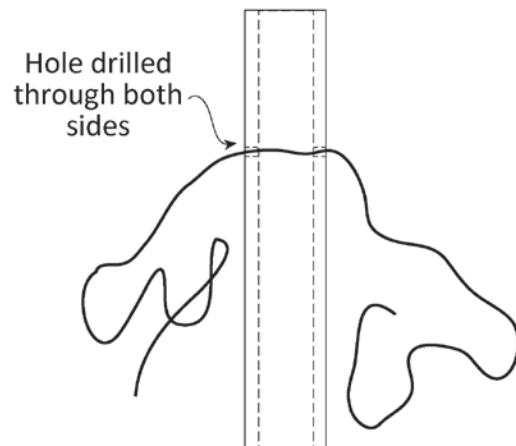


Figure 3: Thread cord through barrel

9. Straighten the paper clip, leaving a hook on the end. Use it to reach into the breach end and pull a loop of the cord out of the PVC pipe. (see figure 4)

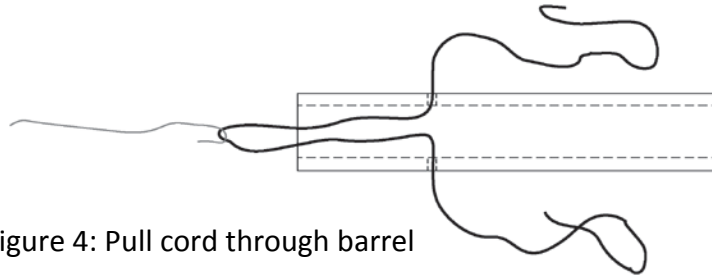


Figure 4: Pull cord through barrel

10. Slip the loop of the chord though the diagonal slot on the plunger. Pull the ends of the cord as you slip the plunger into the pipe, slot end first. (see figure 5)

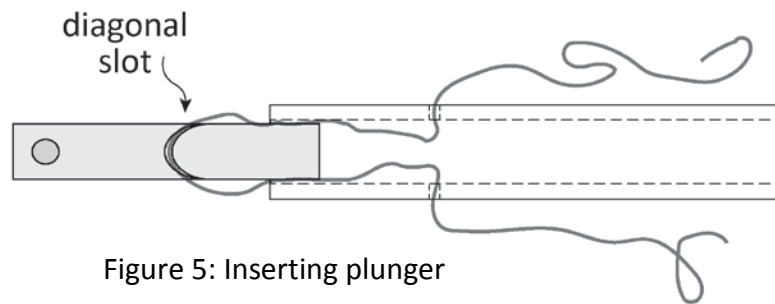


Figure 5: Inserting plunger

11. The button will prevent the plunger from going through the pipe. When the plunger is in the pipe as far as it will go, pull the cords to take up the slack, but do not stretch them. Leave a long enough tail on each end of the chord to allow you to tape the ends to the pipe near the open end.
12. Now your marble shooter is ready to use! Put the marble in the open end, place the shooter at the top of the roller coaster, pull the plunger back, and test it. You can experiment with different size elastic chords and positions to tape the end to get the best result.