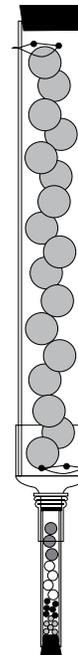


ICE Devices

Chromatography Simulator

The simulator is an easy and fun way to illustrate column chromatography, a technique used to separate components of a mixture. The column is composed of ping pong balls in a clear acrylic tube. The mixture to be separated is composed of spheres of various sizes.



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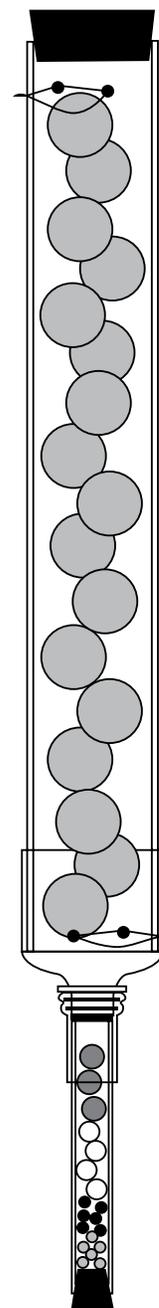
Chromatography Simulator

By Robert Shaner

The simulator is an easy and fun way to illustrate column chromatography, a technique used to separate components of a mixture. The column, like an earlier one [Habich, A.; Häusermann, H. R. *J. Chem. Educ.* 1986, 63, 715], is composed of ping pong balls in a clear acrylic tube. The mixture to be separated is composed of spheres of various sizes.

Materials

- ___ #2 solid rubber stopper
- ___ 60 cm (2 ft) of thin picture-framing wire
- ___ 3 ea. 15-mm marbles
- ___ 4 ea. 13-mm wood spheres (available at craft stores)
- ___ 50 ea. 6-mm plastic spheres (available at craft stores)
- ___ 50 ea. 6-mm metal spheres (BBs, available at hardware stores)
- ___ a drill and an 1/8" drill bit (for drilling acrylic)
- ___ a heat gun or hair dryer (to shrink the plastic soda bottle and heat-shrink tubing, if used)
- ___ scissors
- ___ diagonal wire cutters
- ___ needle nose pliers
- ___ utility knife
- ___ rubbing alcohol and cotton balls
- ___ clear, carton-packaging tape
- ___ (optional) 3 cm (1 1/4 in) of 1" heat-shrink tubing
- ___ (optional) 5 cm (2 in) of 3" heat-shrink tubing
- ___ 35 table tennis (ping-pong) balls
- ___ 122 cm (4 ft) of clear acrylic tubing (available at plastics supply centers) *
5.72-cm (2 1/4-in) I.D. (must be exact) & 0.318-cm (1/8-in) wall
- ___ 30 cm (1 ft) of clear acrylic tubing (available at plastics supply centers) *
2.54-cm (1-in) O.D. & 0.318-cm (1/8-in) wall
- ___ (optional) 5 cm (2 in) of clear, flexible plastic tubing
2.54-cm (1-in) I.D. & 0.318-cm (1/8-in) wall
- ___ upper portion of either a 1-L (33.8-oz) or 20-oz, clear, colorless, plastic soda bottle
- ___ #12 solid rubber stopper or bottom portion of either a 1-L (33.8-oz) or 20-oz. clear plastic soda bottle



* **Acrylic tubing:** If tubing cannot be found locally, check the Internet for "plastics" or contact Allied Plastics, Inc. 9445 East River Road NVV, Minneapolis, MN 55433; <http://www.alliedplastics.com>; search for acrylic tubing.

Preparation

1. Obtain either a 1-L (33.8-oz) or a 20-oz, clear, plastic soda bottle. Take off the label and clean both the inside and outside of the bottle. Remove the label adhesive with cotton balls soaked with rubbing alcohol.
2. Using a utility knife, cut away the bottom half of a 1-L bottle or the bottom quarter of a 20-oz bottle (see Figure 1).

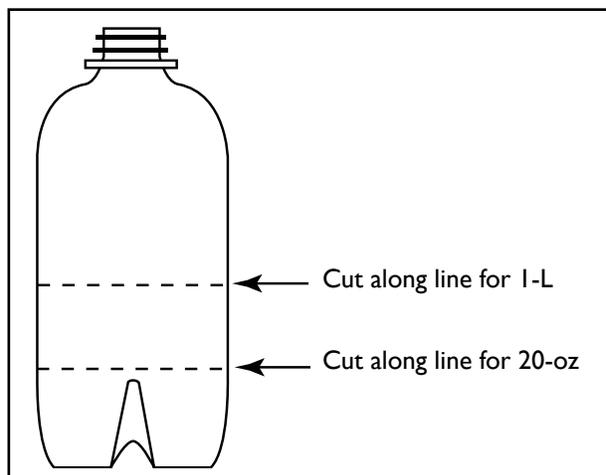


Figure 1. Cutting the plastic soda bottle.

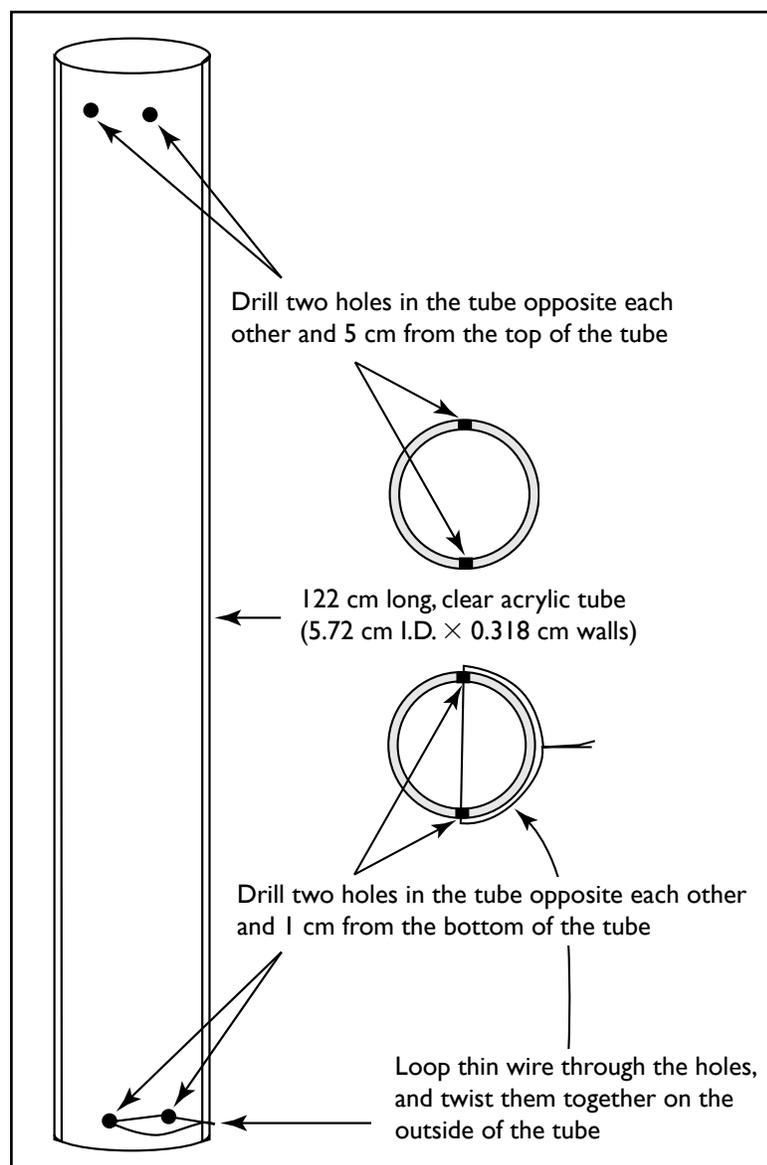


Figure 2. Drilling holes and inserting a wire loop into the larger acrylic tube.

3. Drill two holes 5 cm (2 in) from the top of the larger acrylic tube on opposite sides of the tube. Use a 1/8" drill bit (See Figure 2).
4. Drill two holes 1 cm (1/2 in) from the bottom of the tube on opposite sides of the tube. Use a 1/8" drill bit (see Figure 2).
5. Cut 30 cm (1 ft) of thin wire and loop it through the two holes at the bottom of the acrylic tube. Twist the ends together on the outside of the tube to hold the wire in place. Trim off excess wire using the wire cutters.

6. Push the soda bottle over the acrylic tube until the neck of the bottle fits snugly against the bottom rim (see Figure 3).
7. Using a heat gun (set between 400 and 600 °F) or a hair dryer, shrink the soda bottle around the acrylic tube. Try not to heat the neck of the soda bottle. If using the heat gun, be careful not to overheat the acrylic tube, causing it to melt.

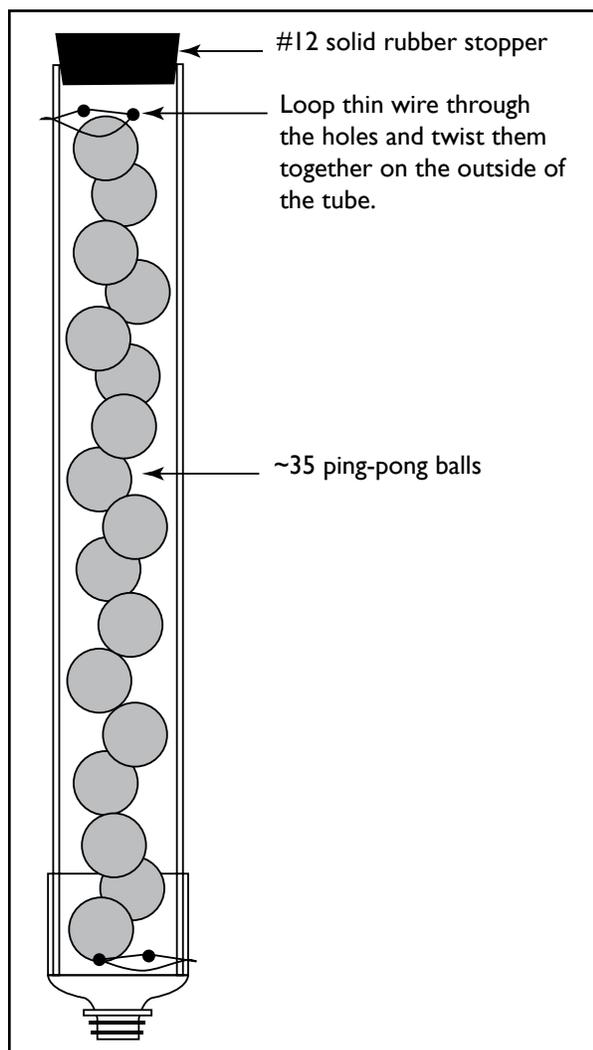


Figure 4. Inserting ping-pong balls into the acrylic tube.

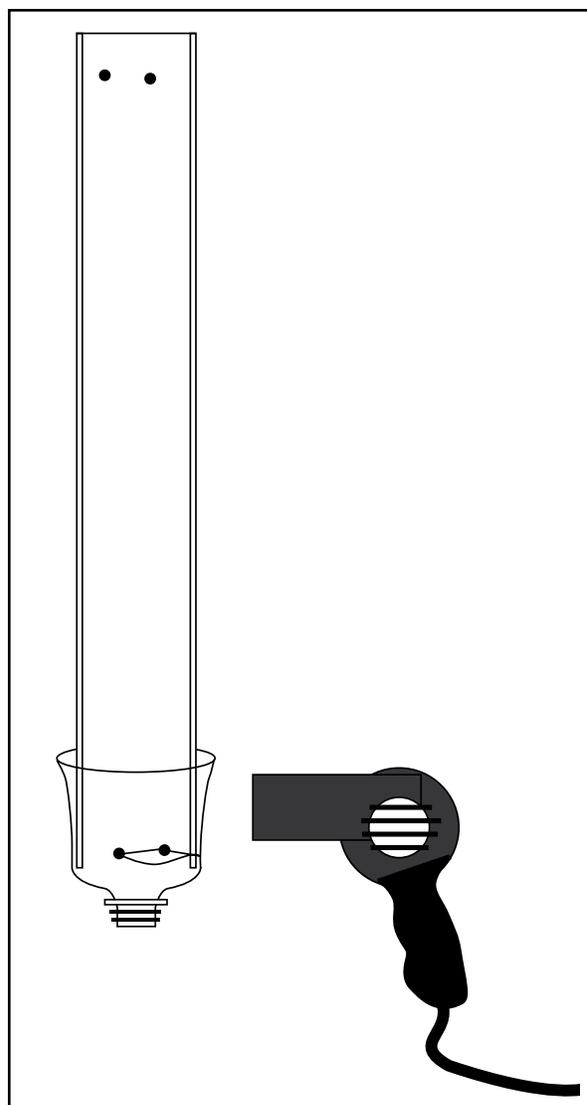


Figure 3. Shrinking the upper portion of the plastic bottle around the bottom of the large acrylic tube using a hair dryer.

8. Insert about 35 ping-pong balls into the large acrylic tube. The exact number of balls is determined by making sure that the top of the highest ball is about 1.5–2.5 cm (1/2–1 in) below the drilled holes (Figure 4).
9. Cut 30 cm (1 ft) of thin wire and loop it through the two holes at the top of the acrylic tube. Twist the ends together on the outside of the tube to hold the wire in place. Trim excess wire using wire cutters (Figure 4).

10. Insert a #12 solid rubber stopper into the top of the acrylic tube. Alternatively, use the heat gun to shrink the bottom half of a soda bottle over the end.
11. Obtain a 5-cm (2-in) long piece of clear, flexible-plastic tubing [2.54-cm (1-in) I.D.], **or** cut clear, carton-packaging tape into six 2.5 × 15-cm (1 × 6-in) strips.
12. a. *If using plastic tubing:* Slide 3 cm of it over the end of the small acrylic tube. Slide the rest of the Tygon® tubing over the top of the soda bottle. Try to get a snug fit.
b. *If using clear tape-strips:* Wrap them diagonally around the tube and the top of the soda bottle so that a crisscrossing pattern develops. The connection should be fairly rigid; if necessary, use extra tape to achieve this (see Figure 5).
13. You may need to use some clear carton tape to keep the plastic bottle from slipping away from the acrylic tubes.

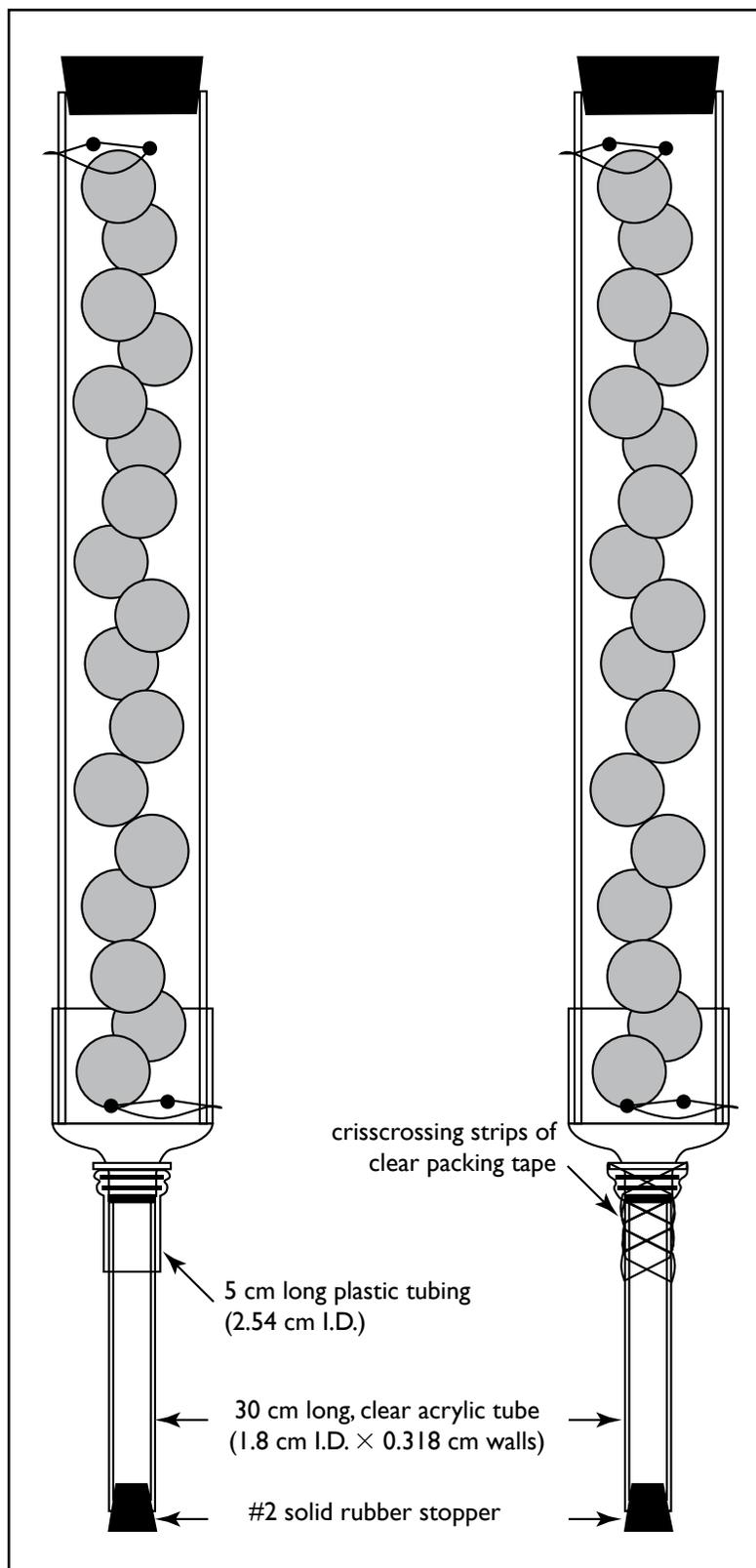


Figure 5. Connecting the smaller acrylic tube to the bottle top.

14. Insert the following spheres into the small tube: three 15-mm glass marbles, four 13-mm wood spheres, fifty 6-mm plastic spheres, and fifty 6-mm metal spheres. Insert the #2 solid rubber stopper into the bottom of the small tube.
15. You may wish to slide heat-shrink tubing over the two rubber stoppers and heat them with a heat gun or hair dryer. This will hold the stoppers in place.

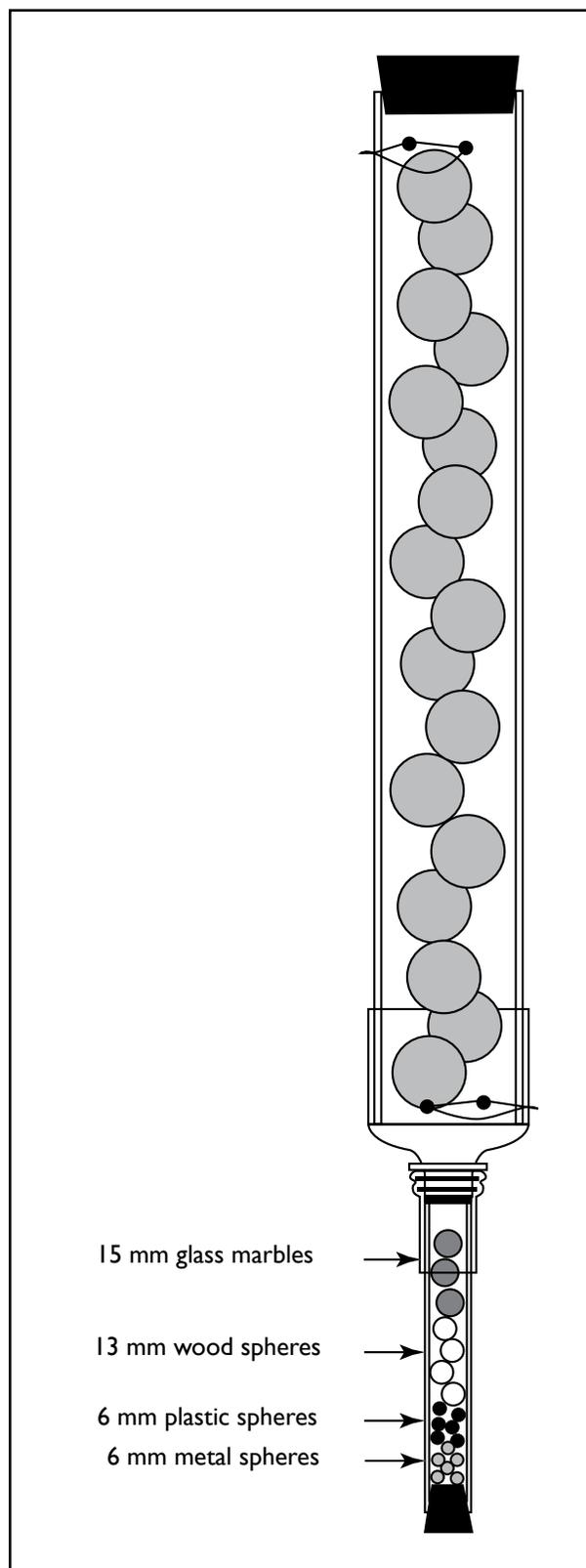


Figure 6. Inserting the various spheres and sealing the tube.

Presentation

1. Flip the column so that all the spheres rest on the large stopper.
2. Quickly turn the column over and watch the spheres roll down through it.
The four types of spheres travel down at different rates due to their differing sizes and densities reacting to the column.
3. The demonstration may be repeated by just flipping the column again.

What is Chromatography?

Column chromatography involves two phases: a mobile phase, which is the mixture to be separated, and a stationary phase. The mobile phase passes through the stationary phase, resulting in a separation of the mixture into its parts. The separation occurs because mobile components are attracted to the stationary phase to different degrees. Components that are strongly attracted are detained by the column, and thus pass through more slowly than do components that are less attracted.