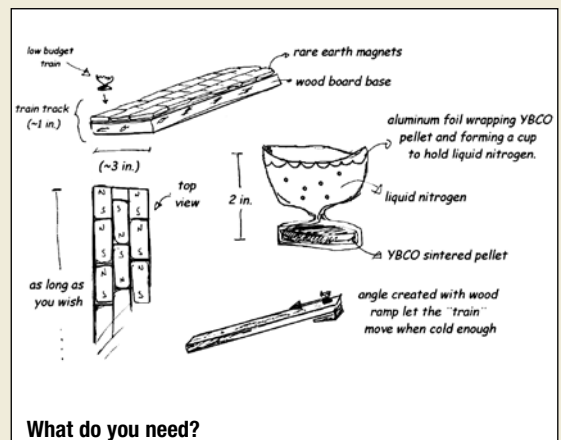


# Super Materials: Levitation

Levitation always impresses students even if they have seen it before. This activity uses rare-earth magnets and YBCO superconductor pellets. While you can buy the rare-earth magnets (we recommend a grade N52), and sinter your own YBCO in a lab, there are also kits available for purchase. The kits will demonstrate the phenomenon and even provide methods to quantify critical temperatures and other properties.

In this activity we have built our own miniature superconductor-train that levitates over its track. This is the basis of a known and used technology that enables faster and more economical transport. Our “track” is a wood base with rare-earth magnets glued on one surface as shown. Note that magnets in the middle row are aligned with opposite poles; this is to better “hold” the train on the track. These are very strong magnets, so you will need superglue to affix them to the track in this configuration. To build the “train,” we use a 2-inch diameter YBCO disc pellet and wrap it with aluminum foil shaped as a cup to hold liquid nitrogen. This will allow the YBCO to be cooled to superconducting temperature. To test the setup, lift one end of the track and place the train on that end. Pour liquid nitrogen into the aluminum foil cup. When the superconductor is below the critical temperature, the train will move down the track. The effect will last until the liquid nitrogen boils away, so, you can pick up the opposite end of the track and move the train back and forth. Have students come close to see that the train does not touch the track.

**What do they learn?** Superconductors can levitate because of their magnetic properties and technologies such as levitating trains can be designed. This is a temperature-dependent phenomenon, and materials engineers are looking for high-temperature superconducting materials.



## What do you need?

Grade N52 rare-earth magnets (at least 30 depending on track length) approximately  $\frac{1}{2} \times 1.5 \times 0.1$  inches, a wood board track at least 20 inches long  $\times$  about  $\frac{1}{2}$  inch  $\times$  4.6 inches, 2-inch diameter YBCO pellet 0.1 in. thick; cryogenic liquid nitrogen container, liquid nitrogen, aluminum foil.