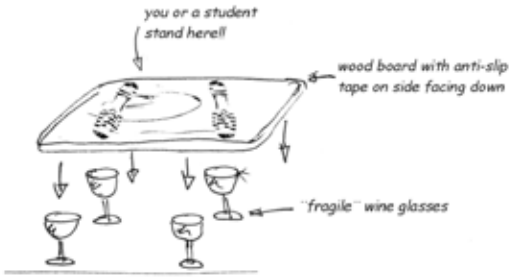
Strong Materials: If it's glass, it's weak, right?

After breaking glass mugs in the first experiment, the concept of the "weakness" of glass is in the students' minds. To flip this perspective, we perform an experiment to show that glasses can withstand high compressive loads.

To do this, place four wine glasses (which look very delicate) on the floor, then place a wooden board on top of the glasses as shown. Now, ask a student to carefully stand on the board. Students will be amazed that the glasses will not break. In fact, the experiment will still work if you remove one or more glasses. Even a single glass would do, but be careful—balance is a major issue! Keep in mind that glasses are not so resistant to bending, so they may break if an angle is formed when standing. Adhesive foam or rubber tape affixed to one side of the board to avoid sliding may be a good idea. After the experiment, you can take one of the wine glasses and break it using the setup from the first experiment to show there is no trick.

Another experiment with glass will show that its low resistance to impact (demonstrated twice in the previous experiments) can be improved to exploit another feature of glass: transparency.

Windows, computer monitors, and many other things are made of glass. While the concepts of tempering and chemical strengthening are perhaps too complex for the majority of students (but could be introduced to an advanced class), use of a plastic-glass composite may prove instructive. Use three glass sheets about 1 mm thick and about 6 × 6 in. Break one to show how easy it is. Then, glue the remaining sheets together using polyvinyl alcohol (PVA) glue. Although still transparent, the composite is much stronger. Trying to break the composite glass will show an impressive difference in the force needed to break it and how it cracks.



What do you need?

Set of four wine glasses, a wooden board approximately 18 inches square, foam tape or other non-slip surface to apply on one side of the board, empty soda cans, PVA glue, three pieces of glass approximately 1 mm thick and 6 inches square.

While you can demonstrate in class how the composite glass sheet is made, you might need to bring a premade sheet—the glue takes some time to dry. Also prepare beforehand a PVA film by applying it to a greased surface and allowing it to dry. Show the students that it is fairly transparent, similar to glass, but soft. The composite combines the mechanical properties of PVA and glass to form a stronger transparent material. A good example of this is the plastic-reinforced windshields in modern cars that increase safety (though it uses PVB instead).

What do they learn? Every material can be "strong" if designed for the right application. Different loads and angles, as well as the speed with which the load is applied, will cause a different behavior. Composite materials can combine properties of two or more components to create new features and solve particular application problems.