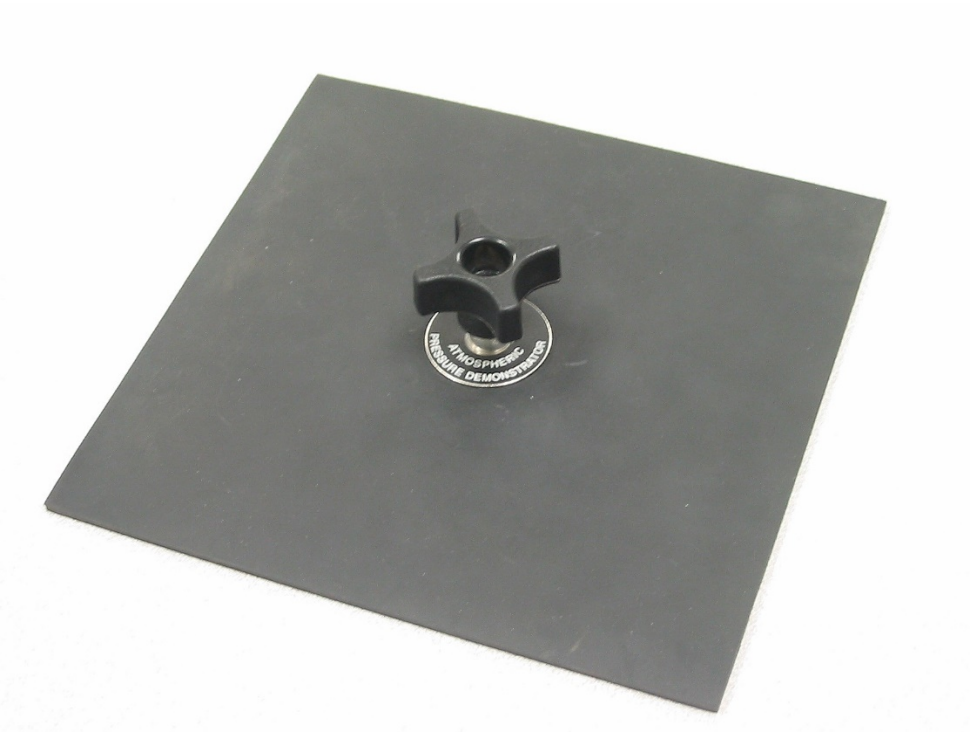
Vacuum Lifter



TheLifter

Purpose: Demonstrates the force of atmospheric pressure.

This demo consists of a rubber sheet with a reinforced handle. When placed on a smooth, flat object and pulled by the handle it exerts a pull on the object because of the “force due to atmospheric pressure.”

The lifter is 7 ¾ in. square, so a rough calculation implies you could (in theory) lift about 840 lbs. In practice, the handle would rip out of the rubber.

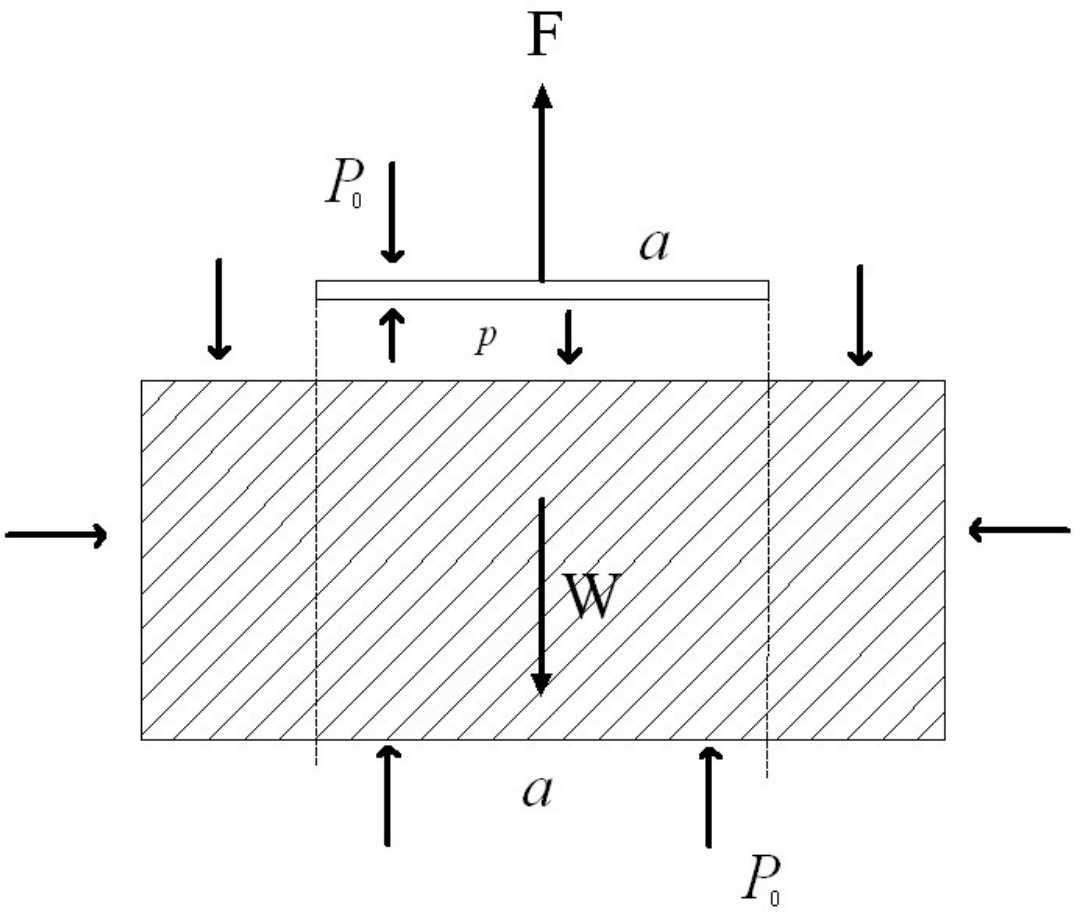
However, you can lift plenty with it: in the photo below, Jim is hoisting one of the demo carts using the vacuum lifter on the top surface. (The nonskid pad was removed of course.)

Steroids?

Note: This is a good demo, but perhaps confusing to any students who actually think about it: What is actually lifting the object? If air pressure is pushing down on the rubber sheet with 840 lbs. how can you lift anything?

The explanation is (of course) that when pulled up, the sheet creates a partial vacuum (pressure *p*) between itself and the object to be lifted.

Some kind of diagram like this helps:



Now it is apparent that, for a static situation, the weight of the object is $W = a|P_0 - p|$. The object is actually floated by the difference in air pressure between the bottom and top (over an area *a*)!

Statics applied to the lifter yields $F = a|P_0 - p\,|$, so that $W = F$. You are pulling up, not on the weight, but on the partial vacuum!
Note the vacuum is not much of a vacuum really. Suppose you lift 60 lbs:

$p = P_0 - W/a = P_0 - 60 \text{ lbs}/60 \text{ in}^2 = 14 - 1 \text{ psi}$.

Extra Equipment: None — maybe something to lift.

Location: Shelf D4