

## The Discovery of Air Pressure: A Brief History \*

### The Problem: Pumping Water out of Mines

The problem of pumping water out of mines was both puzzling and expensive. It was mysterious that water could not be pumped higher than 32 feet. In trying to explain what was going on, people focused on obvious variables such as imperfections in the pumps themselves or fluid that seeped in from outside the pump. Non-obvious variables, such as air pressure, were not considered as an explanation for the puzzle.

### Moving Toward a Solution: Torricelli's Experiment



In 1643 Evangelista Torricelli, a mathematician who had studied with Galileo, became convinced that the weight of the air pushing on the pool of water at the foot of the mineshafts had something to do with the height to which water would rise. He designed and had his assistant, Vincenzo Viviani, carry out an experiment to test the idea. Viviani took a 6 foot long glass tube and filled it with mercury. Then he placed his finger over the opening and inverted the tube into a bowl of mercury with the sealed end up, and measured the resulting height of the mercury column.

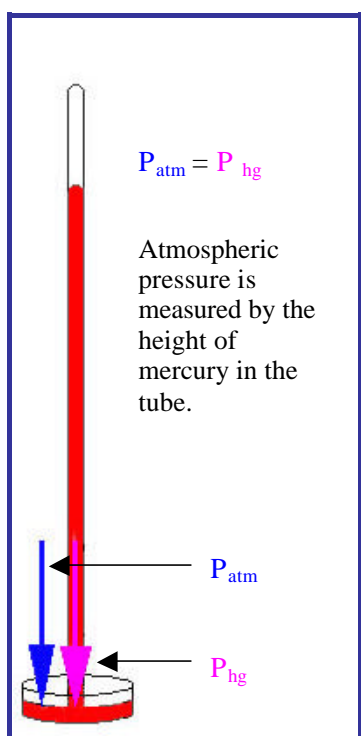
(Mercury, with a density of 13.6 g/ml., is much denser than water. Torricelli realized that if he used mercury he would not have to use such a long tube. If he used water, he would have needed a column of water 13.6 times that of mercury, or about 32 to 33 feet high. Recognize that number? Of course, today we know that working with mercury has some serious health risks!)

\*This information was adapted from Burke, J. (1978). *Connections*. Boston: Little, Brown & Company.

The mercury fell instead of remaining at the top, and an empty space, or vacuum, was created at the top of the tube. (At the time, scientists thought that a vacuum was impossible. Galileo believed that no such thing existed; however, some of Torricelli's friends had been secretly experimenting to see if one could be created.)

Torricelli observed that the column of mercury rose and fell in a manner that corresponded to the weather. On clear days, the column would be relatively high, but before and during a storm, it would drop. He realized that the height of the mercury column must be in some way connected with the atmosphere.

### Measuring Air Pressure



Torricelli reasoned that the weight of the column of mercury was equal to the weight of the air column pushing down on the bowl of mercury. If the weight of either one changed, then the height of the column of mercury should also change.

Torricelli's findings spurred many new discoveries, such as the behavior of gases, the existence of oxygen and so forth. It also led to technological innovations such as jet engines and hot air balloons.

**Making Connections:** How does Torricelli's Tube explain why pumps could not pull water out of mines from a depth greater than 32 feet?