

The Magdeburg Hemispheres Demonstration by: William C. Deese

Description: Two hemispheres are placed together to form a sphere. A vacuum pump is attached and most of the air is pumped out of the sphere. Two volunteers from the audience are challenged to separate the hemispheres by pulling in opposite directions. They are unable to separate the spheres. The valve is opened and the hemispheres separate easily.

Topics: Air pressure, vacuums, kinetic molecular theory.

Materials: Magdeburg hemispheres (e.g. www.sciencefirst.com Item 35-070)
Vacuum pump. (Nalge Nunc International 6130-0010 is a hand-operated one)

Procedure:

- 1) Attach the vacuum pump to the hemispheres and open the valve.
- 2) As you describe the original demonstration by Otto Von Guericke, evacuate the sphere.
- 3) Close the valve and remove the vacuum pump tube.
- 4) Select two audience members and ask them to attempt to pull the hemispheres apart. Caution them about the possibility of falling if they succeed.
- 5) Usually their efforts will be futile. Open the valve and easily separate the hemispheres.

Discussion: This is an excellent time to discuss kinetic molecular theory. When the hemispheres are evacuated, there are very few gas molecules inside to fly about and strike the inside of the sphere. Therefore, little force is exerted on the inside of the sphere and the pressure is very low. Air molecules on the outside strike the surface of the sphere and exert a tiny force. The sum of the forces created by billions of collisions per second creates a pressure of one atmosphere pushing toward the center of the sphere. Opening the valve allows air to rush in until the inside pressure equals atmospheric pressure and the hemispheres fall apart.

Reference: Common demonstration apparatus sold in many catalogs.

Otto Von Guericke



1602-1686