STANDARD EQUILIBRIUM TUBE

DESCRIPTION

This apparatus consists of a large reservoir tube connected by a manifold to three smaller tubes of different shapes. It may be mounted on the stand.

DEMONSTRATION

Add a few drops of red food color to about 60ml of water. This makes the demonstration easier to see. Ask the students to predict what will happen when water is added to the reservoir tube. After discussion of the student responses slowly fill the large tube with the colored water. Ask the students to explain what they see. You may wish to repeat the demonstration with different liquids, or have a student cover the end of one or more tubes while the apparatus is being filled. Also you may tilt the apparatus slowly and note that the water level always stays parallel to the floor.

THEORY

The level of water in each tube is determined by the pressure of the atmosphere. Since air pressure is measured in N/m² it follows that the actual cross sectional area of an individual tube has no effect on the water level. According to Pascal's Principle pressure applied to a liquid in a closed container is transmitted without being reduced to all parts of the liquid, and to the walls of the container. In an open system such as this the pressure is due to the weight of the column of air above each tube. Since air pressure is the same at any one point on earth, and since it is not dependent on surface area, all the tubes will have the same pressure being exerted on them.

Some students may point out that one of the tubes has a greater volume that is exposed to the atmosphere. This tube has two bulges in it, and the students seem to feel that this larger volume should affect the height of the water. However, as can be seen in the drawing, the water in these bulges is being supported by the glass beneath them, and so has no effect on the equilibrium.

After demonstrating this phenomena, try different ways of working with the apparatus. Have a student seal the end of one of the tubes while the apparatus is being filled. The water in that tube will not be able to displace the air in the tube, and will have to compress it. Because of this the water level will be lower in that tube than in the others. In effect the student has made a barometer.

It is especially interesting to follow this demonstration with a demonstration of the capillary equilibrium tube.