Pressure

Definition

Pressure is defined as the force per unit area in a gas or a liquid. For a solid the quantity force per unit area is referred to as stress.

Unit of pressure

In the metric system pressure is measured in dynes per square centimeter or newtons per square meter; the SI unit for the latter is the pascal (Pa). Table 1 lists some of the common units used to measure pressure and gives atmospheric pressure in each system.

Table 1 Some of the units used to measure pressure

	Atmospheres	N/m^2	$cm\ H_2O$	mm Hg	$lb/in.^2$ (psi)
1 atmosphere	1	1.01×10^5	1033	760	14.7
1 N/m^2	0.987×10^{-5}	1	0.0102	0.0075	0.145×10^{-3}
1 cm H_2O	9.68×10^{-4}	98.1	1	0.735	0.014
1 mm Hg	0.00132	133	1.36	1	0.0193
1 $lb/in.^2$ (psi)	0.0680	6895	70.3	51.7	1

Pressure calculation

The pressure P under a column of liquid can be calculated from

$$P = \rho g h$$

Where ρ is the density of the liquid, g is the acceleration due to gravity, and h is the height of the column.

Absolute and gauge pressure

Since we live in a sea of air with a pressure of 1 atm, it is easier to measure pressure relative to atmospheric pressure than to measure true, or absolute pressure. For example, if the pressure in a bicycle tire is 60 $lb/in.^2$, the absolute pressure is 60+14.7, or nearly 75 $lb/in.^2$ The 60 $lb/in.^2$ is the gauge pressure.

Negative pressure

There are a number of places in the body where the pressures are lower than atmospheric, or negative. For example, when we breathe in (inspire) the pressure in the lungs must be somewhat lower than atmospheric pressure or the air would not flow in. The lung pressure during inspiration is typically a few centimeters of water negative. When a person drinks through a straw the pressure in his mouth must be negative by an amount equal to the height of his mouth above the level of the liquid he is drinking.

Measurement of pressure in the body

The classical method of measuring pressure is to determine the height of a column of liquid that produces a pressure equal to the pressure being measured. An instrument that measures pressure by this method is called a manometer. A common type of manometer is a **U**-shaped tube containing a fluid that is connected to the pressure to be measured (Fig. 1). The levels in the arms change until the difference in the levels is equal to the pressure. This type of manometer can measure both positive and negative pressure. The fluid used is usually mercury, but water or other low density fluids can be used when the pressure to be measured is relatively small.

The most common clinical instrument used in measuring pressure is the sphygmomanometer, which measures blood pressure. Two types of pressure gauges are used in sphygmomanometers. In a mercury manometer type the pressure is indicated by the height of a column of mercury inside a glass tube. In an aneroid type the pressure changes the shape of a sealed flexible container, which causes a needle to move on a dial.

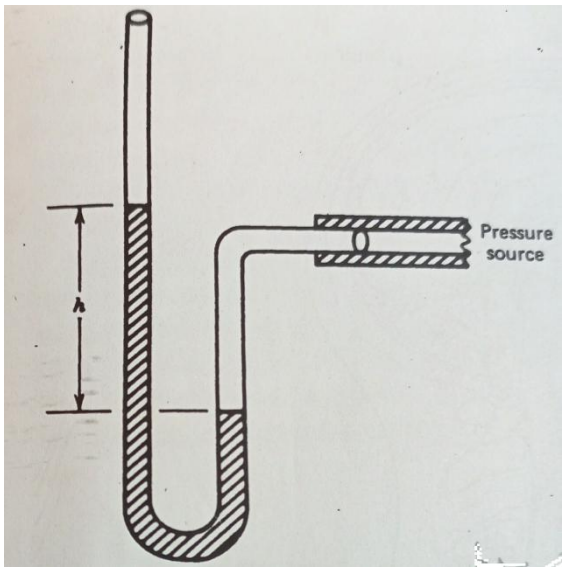

Figure 1

Some parts of the body can act like crude pressure indicators. For example, a person going up or down in an elevator or an airplane is often aware of the change in atmospheric pressure on the ears. When one swallows the pressure in the middle ear equalizes to the outside pressure and the eardrums " pop." It is necessary for the ears to be very sensitive to pressure since pressure changes in an ordinary sound wave are extremely small. Another qualitative pressure indicator is the size of the veins on the back of the hand. As a hand is raised slightly above the level of the heart these veins become smaller due to the lower venous blood pressure.