Physics of Diving

Water Weight and Pressure

Environmental pressure or air pressure is caused by the weight of the layers of the atmosphere above (air molecules). Water also exerts pressure due to the weight of its molecules, which are heavier than those of air. The pressure exerted by the weight of a liquid is called hydrostatic pressure. The deeper we dive, the greater the hydrostatic pressure on our body.

This phenomenon is very common for people diving into a pool. When submerging in water, they will feel pain in the ears due to the increase (descent) or decrease (ascent) in pressure. To avoid ear pain while diving, you must achieve equal pressure inside and outside the ear—internal pressure equal to ambient pressure.



Jonathan Levy in a coral reef of Little Corn Island. Photo by Fabio Buitrago.

RELATIONSHIP BETWEEN PRESSURE, VOLUME, AND DENSITY

DEPTH	PRESSURE	AIR VOLUME	DENSITY
Surface	1 bar/atm	1	x1
10 m / 33 ft	2 bar/atm	1/2	x2
20 m / 66 ft	3 bar/atm	1/3	x3
30 m / 99 ft	4 bar/atm	1/4	x4
40 m / 132 ft	5 bar/atm	1/5	x5

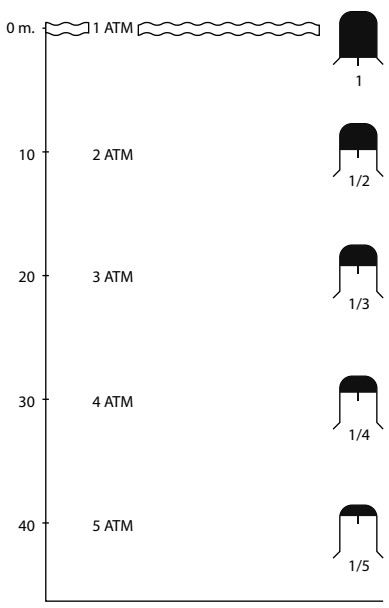


Every time we dive into a body of water, we experience hydrostatic pressure, referring to the weight of the water compressing the gaseous spaces inside our body.

Gases and Pressure

Air is composed of different gases. Nitrogen (N_2) represents 78%, and oxygen (O_2) represents 21% of the main components. Each gas behaves differently at different pressures, volumes, and temperatures. The key point to remember is that at a constant temperature, if the pressure increases, the volume of a gas decreases inversely. Thus, a balloon filled with air is twice as small at 10 meters deep (2 atmospheres of pressure) than it is on the water's surface.

These physical principles are relevant for many aspects of diving, such as air consumption and the volume of air-filled spaces in our equipment and body. It is also possible to dive with different gas compositions.

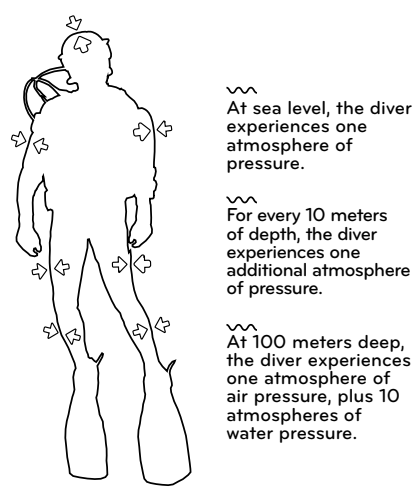


The absorption of gases by human body tissues depends on the composition of the gases breathed underwater, as well as the depth (pressure) at which they are breathed. The deeper one dives, the greater the pressure, and therefore, the greater the dissolution of gases in the diver's tissues.

Our Body and Hydrostatic Pressure

Liquids constitute an important part of the human body, which also has hollow spaces filled with air (gas). When diving, these gases contained in our body can dissolve in liquids due to the increased hydrostatic pressure and affect gas spaces such as the lungs, sinuses, ears, digestive tract, blood, and body tissues. This is a crucial phenomenon in diving as it determines the allowed dive time, ascent rate, and can result in decompression stops.

Another important law known as Henry's Law tells us that at a constant temperature, a liquid absorbs a certain amount of gas until the pressure of the dissolved gas in the liquid is equal to the pressure of the gas in contact with the liquid. How gas dissolves in a liquid depends on pressure, time, temperature, contact surface, and the type of gas and liquid. What is essential to remember for diving is that if the pressure increases, the liquid (our body) can contain more gas in solution.



The human body is mainly composed of liquids, so hydrostatic pressure does not directly affect it. However, gas spaces such as the lungs, sinuses, ears, and digestive tract can be affected by the increased pressure from diving.