Flotation Therapy: Rejuvenating the Body in a Body of Water

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THE APPLIED PRINCIPLES OF BUOYANCY

Extract from The Royal Life Saving Society of Australia
Manual of Water Safety 1957- 1977

In teaching these principles for applied water skills in rehabilitation and physical fitness strengthening, although the following extract may appear relatively classic these notes remain the best published explanation to date.

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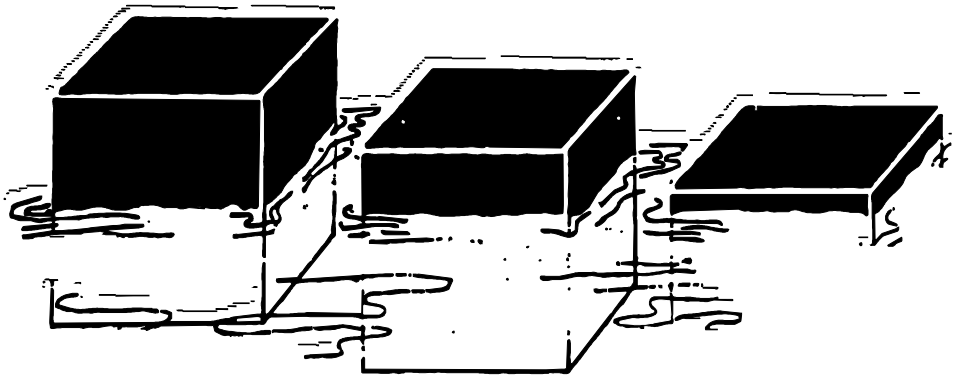
Human survival in water is dependant frequently upon securing and maintaining maximum buoyancy of the body with a minimum expenditure of energy. It is important, therefore, that the principles governing buoyancy and energy conservation be understood by those acquiring skills of survival and, perhaps, should become as basic a part of the public's general knowledge as should be the rules of water safety.

The physical properties of objects and the fluids in which they are submerged influence buoyancy. Archimedes' principle states that when a body is wholly or partially submerged in a fluid an upward buoyant force is exerted on the body which is equal to the weight of the fluid displaced. A swimmer in water, therefore, will have an upward force acting on the body and he will float when this' force is equal to the weight of the volume of water which he displaces. When the upward force of the water exceeds the downward force of the body he will float with a part of the body out of the water, and when it is less than the body's weight he will sink.

The weight of an object is related to its density since density is a measure of how much of the object's mass is packed into a given volume. A comparison of the densities of substances can be made with 'the density of fresh water to give a measurement known as specific gravity. The specific gravity of pure distilled water at 4°C. is 1.0, but the variations in the specific gravity of fresh water are so small that for convenience sake they are ignored.

Thus, a comparison of the specific gravities of other substances with that of fresh water will indicate whether or not they will float in fresh water. If, there- fore, the specific gravity of a substance is less than 1.0 it will float on the surface' of the water because it is less dense than water. In general, then, any solid will float in a liquid if it is less dense than the liquid. Because salt water has a specific gravity of approximately 1 .03, it is easier, relatively, to float in salt water than in fresh water.

Consequently, an object such as a block of wood weighing half the weight of an equal volume of water will float with half of its bulk out of the water. When this happens in fresh water, the specific gravity of the wood is 0.5 Similary, a block of **wood three quarters of the weight of an equal volume of water will float with one-quarter 'of its bulk out of the water and, if in fresh water, it will have a specific gravity of 0.75. A block of wood with a specific gravity of 0.98 will weigh forty-nine fiftieths of the weight of the water displaced and will float with one fiftieth of its volume above the surface when in fresh water.**



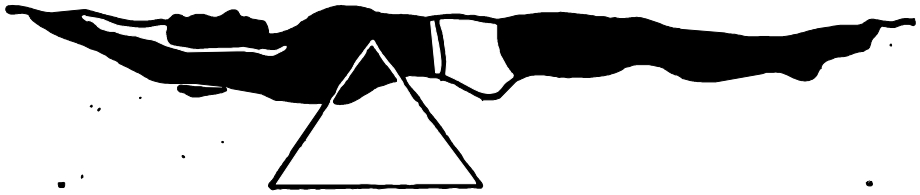
Specific gravity 0.5 **Specific gravity 0.75** **Specific gravity 0.98**

The specific gravity of the human **body** varies in individuals between 0.96 and 1.20. Thus some people will possess the physical properties to enable them to float motionlessly with ease on the surface of fresh water while others will tend to sink.

Those who sink will require making slight movements of the arms and legs and/or making adjustments to the body's balance to enable them to stay afloat. In such cases, the body suffers a loss of energy through the muscular exertion of swimming or treading water which is required to force the body upwards thus compensating for the lack of buoyancy.

The specific gravity of various parts of the human body also varies. The specific gravity of fresh bone is approximately 1.9, of muscle tissue 1.085, while that of fat is 0.7 to 0.98. These facts explain why fat people tend to float more easily than either lean or muscular people and why women possessing more sub-cutaneous fat than men' float more easily than men. It also explains the tendency of the legs to sink when .floating since they are denser and heavier than the top part of the body, which contains the chest with its air-filled lungs acting as inbuilt "buoyancy tanks".

The centre of gravity of the human body is situated approximately at the hips, but the centre of buoyancy is located at the chest. Since the floating body acts as a first-class lever, extension of the hands above the head brings the centre of gravity closer to the centre of buoyancy and tends to equalize the length of the lever at both ends of the fulcrum (centre of buoyancy) counterbalancing the effect of the heavier legs.



Effort ***Fulcrum*** ***Load***

Equilibrium may be aided further by adjusting the position of the head in the water while floating on the back. The head of an adult weighs some 4.5 to 7 kg, thus slightly raising the head out of the water will raise the position of the feet in the water and, conversely, lowering the head in the water will lower the feet. Mechanically, less effort is required to float and to swim when the head is kept in the water because its weight is supported by buoyancy.

Conversely, it is wasteful of energy to float or swim with the head raised clear of the water. Thus, in an emergency in the water, when a person needs to conserve energy for survival, it is important to apply the principle of swimming and floating with the head in the water.
It also is important to relax as much as possible while doing so since relaxation is a means of energy conservation.

Summary and Conclusion

Buoyancy is affected by the volume of air contained in the lungs. A breath of air increases the volume of the body without increasing its weight to any degree and, thus, buoyancy is increased by the resulting decrease in the specific gravity of the body. This explains why some people can float only when the lungs are filled completely with air. Deliberate control of the volume of air in the lungs can aid flotation. Rapid exhalations followed quickly by rapid deep inhalations and periods of breath-holding will help to maintain a maximum air volume in the lungs. If a person can increase the maximum amount of air that he can inhale in one breath, that is, the increase his vital capacity through exercise, he will increase his ability to float.