# Weight Adjustment for Constant Buoyancy When Scuba Diving in Fresh and Salt Water

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A diver and gear can be considered as n objects of mass m and volume V.

Therefore the total buoyancy of the diver and gear is:

$$B = \left( \rho_w - \frac{\sum_{i=1}^{n} m_i}{\sum_{i=1}^{n} V_i} \right) \sum_{i=1}^{n} V_i \qquad [1]$$

where $\rho_w$ = the density of the water

Rearranging equation [1] yields:

$$B = \rho_w \sum_{i=1}^{n} V_i - \sum_{i=1}^{n} m_i \qquad [2]$$

Now let us assume the weights are the $n^{th}$ item and for approximation assume they have negligible (zero) volume. Then equation [2] becomes

$$B = \rho_w \sum_{i=1}^{n-1} V_i - \sum_{i=1}^{n-1} m_i - m_n \qquad [3]$$

However since

$$\sum_{i=1}^{n-1} V_i = V_{diver} + V_{gear} \qquad [4]$$

and

$$\sum_{i=1}^{n-1} m_i = m_{diver} + m_{gear} \qquad [5]$$

equation [3] becomes

$$B = \rho_w \left( V_{diver} + V_{gear} \right) - m_{diver} - m_{gear} - m_{weights} \quad [6]$$

Now assuming we want identical buoyancy in fresh and salt water.

$$B_{SW} = B_{FW} \quad [7]$$

If $m_{FW}$ = mass of the weights in fresh water,
$m_{SW}$ = mass of the weights in salt water,
$\rho_{SW}$ = density of salt water,
and $\rho_{FW}$ = density of fresh water,

equation [7] becomes:

$$\rho_{SW} \left( V_{diver} + V_{gear} \right) - m_{diver} - m_{gear} - m_{SW} = \rho_{FW} \left( V_{diver} + V_{gear} \right) - m_{diver} - m_{gear} - m_{FW}$$

rearranging the above equation yields:

$$m_{FW} - m_{SW} = \left(\rho_{FW} - \rho_{SW}\right) \left( V_{diver} + V_{gear} \right) \quad [9]$$

Therefore the change in weights from fresh to salt water is equal to the density difference times the volume of the diver and gear. Or in mathematical notation:

$$\Delta m = \Delta\rho \left( V_{diver} + V_{gear} \right) \quad [10]$$