Diver Pressure

You and a friend are going scuba diving in three different locations. You know that:

depth of each dive = 10 *m*

density of fresh water = $\rho_{water} = 1{,}000\ kg/m^3$ density of salt water $\rho_{water} = 1{,}025\ kg/m^3$

sea level air pressure = $P_0 = 1.00\ x\ 10^5\ Pa$ density of air = $\rho_{air} = 1.29\ kg/m^3$
(we will assume that this is constant)

A	B	C	D	E	F	G	H
Dive	Water type	height above/below sea level h_{dive} at which the dive begins in *m*	P_{air} at the given height above/below sea level in *Pa*	ρ_{water} needed to calculate the pressure at 10 *m* depth in kg/m^3	P_{10m} pressure at the dive depth in *Pa*	$\frac{P_{10m}}{P_{air}}$	Pressure change ratio rank
FW1	fresh	500 m below	$1.06\ x\ 10^5$	1,000	$2.04\ x\ 10^5$	1.92	6
FW2	fresh	0 m, sea level	$1.00\ x\ 10^5$	1,000	$1.98\ x\ 10^5$	1.98	4
FW3	fresh	500 m above	$9.37\ x\ 10^4$	1,000	$1.92\ x\ 10^5$	2.05	2
SW1	salt	500 m below	$1.06\ x\ 10^5$	1,025	$2.07\ x\ 10^5$	1.95	5
SW2	salt	0 m, sea level	$1.00\ x\ 10^5$	1,025	$2.01\ x\ 10^5$	2.01	3
SW3	salt	500 m above	$9.37\ x\ 10^4$	1,025	$1.94\ x\ 10^5$	2.07	1

1) Calculate P_{air} for each dive, $P_{air} = P_0 + \rho_{air} g h_{dive}$. Write the answers in column D.

$$P_{FW1\,air} = P_{SW1\,air} = 1.00\ x\ 10^5\ Pa + (1.29\ kg/m^3)(9.81\ m/s^2)(500\ m) = 1.06\ x\ 10^5\ Pa$$

$$P_{FW2\,air} = P_{SW2\,air} = 1.00\ x\ 10^5\ Pa + (1.29\ kg/m^3)(9.81\ m/s^2)(0\ m) = 1.00\ x\ 10^5\ Pa$$

$$P_{FW3\,air} = P_{SW3\,air} = 1.00\ x\ 10^5\ Pa + (1.29\ kg/m^3)(9.81\ m/s^2)(-500\ m) = 9.37\ x\ 10^4\ Pa$$

2) Indicate which value of ρ_{water} is needed to calculate the pressure at 10 *m* depth. Write the answers in column E.

$1{,}000\ kg/m^3$ for dives FW1, FW2, and FW3 in fresh water

$1{,}025\ kg/m^3$ for dives SW1, SW2, and SW3 in salt water

3) Calculate P_{10m} for each dive using the correct value for ρ_{water}. Write the answers in column F.

$P_{FW110m} = 1.06\,x10^5\,Pa + (1{,}000\,kg/m^3)(9.81\,m/s^2)(10\,m) = 2.04\,x10^5\ Pa$

$P_{FW210m} = 1.00\,x10^5\,Pa + (1{,}000\,kg/m^3)(9.81\,m/s^2)(10\,m) = 1.98\,x10^5\ Pa$

$P_{FW310m} = 9.37\,x10^4\,Pa + (1{,}000\,kg/m^3)(9.81\,m/s^2)(10\,m) = 1.92\,x10^5\ Pa$

$P_{SW110m} = 1.06\,x10^5\,Pa + (1{,}025\,kg/m^3)(9.81\,m/s^2)(10\,m) = 2.07\,x10^5\ Pa$

$P_{SW210m} = 1.00\,x10^5\,Pa + (1{,}025\,kg/m^3)(9.81\,m/s^2)(10\,m) = 2.01\,x10^5\ Pa$

$P_{SW310m} = 9.37\,x10^4\,Pa + (1{,}025\,kg/m^3)(9.81\,m/s^2)(10\,m) = 1.94\,x10^5\ Pa$

4) Calculate the ratio $\frac{P_{10m}}{P_{air}}$ for each dive. Write the answers in column G.

$\frac{P_{FW110m}}{P_{FW1\,air}} = \frac{2.04\,x10^5\,Pa}{1.06\,x10^5\,Pa} = 1.92$ $\qquad$ $\frac{P_{SW110m}}{P_{SW1\,air}} = \frac{2.07\,x10^5\,Pa}{1.06\,x10^4\,Pa} = 1.95$

$\frac{P_{FW210m}}{P_{FW2\,air}} = \frac{1.98\,x10^5\,Pa}{1.00\,x10^4\,Pa} = 1.98$ $\qquad$ $\frac{P_{SW210m}}{P_{SW2\,air}} = \frac{2.01\,x10^5\,Pa}{1.00\,x10^4\,Pa} = 2.01$

$\frac{P_{FW310m}}{P_{FW3\,air}} = \frac{1.92\,x10^5\,Pa}{9.37\,x10^4\,Pa} = 2.05$ $\qquad$ $\frac{P_{SW310m}}{P_{SW3\,air}} = \frac{1.94\,x10^5\,Pa}{9.37\,x10^4\,Pa} = 2.07$

5) Rank the pressure change ratios $\frac{P_{10m}}{P_{air}}$ from highest to lowest, using the number 1 to indicate the highest ratio, the number 6 to indicate the lowest pressure change ratio. Write the answers in column H.