Week 7 Quiz

Thursday, February 18, 2021 10:43 AM

A tardigrade "releases" 1.4 x 10^{-6} kg (0.0001 mol) of an ideal gas. The ocean temperature is about 3 °C at any depth greater than 1000 m. Salty ocean water has a density of 1025 kg/m^3. Assume ocean water is incompressible and that the gas does not dissolve into the water.

(a) If the gas is released deep enough in the ocean, it would actually begin to sink instead of floating to the surface! Explain how and why this would happen. Use any combination of words, diagrams, or mathematical representations.

As you go deeper into the ocean the pressure increases, $P_1 = P_0 + \rho g h$

An ideal gas, $PV = nRT$, at const T + n, will compress as P ↑

w/ density, $\rho = \frac{M}{V}$, as V ↓, ρ ↑. , g-gas + w-water

Eventually $\rho_g > \rho_w$ + it sinks.

(b) What volume would the gas need to occupy in order to be neutrally buoyant? (When the buoyant force = the weight of gas)

$F^B = F^g \Rightarrow \rho_w V_g g = \rho_g V_g g \Rightarrow \rho_w = \rho_g$ ← neutral buoyancy condition

w/ $\rho_g = \frac{M_g}{V} \Rightarrow V_1 = \frac{M_g}{\rho_w} = 1.36 \times 10^{-9} m^3$

(c) How far underneath the surface of the Earth's ocean would the gas need to be before it would begin to sink on its own?

$PV = nRT \Rightarrow P_1 = \frac{nRT_1}{V_1} = 1.679 \times 10^8 Pa$

$P_1 = P_{atm} + \rho_w g h \Rightarrow h = 16{,}707 m$

(d) The deepest part of the ocean is about 12,100 ft deep. Examine your answer to part **(c)** using the known values sensemaking technique.

w/ 16,000m > 12,100 ft, I don't think tardigrade farts are going be sinking.

Rubric

Part (a)	Part (b)	Part (c)	Part (d)
2.5 pts - answer	1 pt - Buoyancy force eq. 1 pt - Density eq. 1 pt - Neutral buoyant condition 0.5 pts - correct answer + units	1 pt - ideal gas eq. 1 pt - Pressure at a depth eq. 1 pt - Application	1 pt - answer