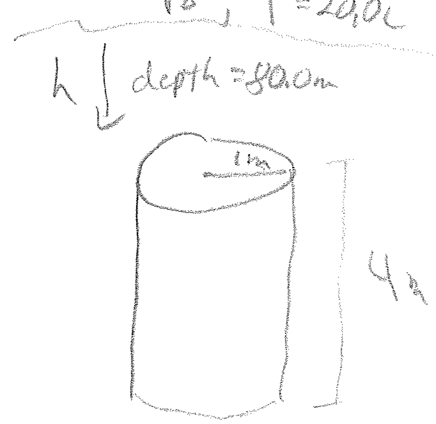
19-12

$P_{inside} = P_{outside} = P_0 + \rho g h$

$P_0 = 1\,atm$, $\rho = 1024\ kg/m^3$



a) $V_{surface} = V_{cyl} = \pi r^2 \cdot h$

$= \pi (1.0m)^2 (4.0m)$ $\qquad T(h) = -3.0\,C$

$= 12.57\ m^3$

b) With no more air added V_{depth} is less as the air is compressed by pressure $P = P_0 + \rho g h = 1.00\,atm + (1024\ kg/m^3)(9.80\ m/s^2)(80m)$ [divided by $1.01 \times 10^5\ Pa$]

(handy rule of thumb: pressure underwater is ~1 atm per 10 m of water)

$= 1.00\,atm + 7.95\,atm = 8.95\,atm$

$pV = NRT$ is ideal gas law, if no air is added N is same,

so $\frac{P_1 V_1}{P_2 V_2} = \frac{NR\,T_1}{NR\,T_2} \Rightarrow V_2 = \left(\frac{P_1}{P_2}\right)\left(\frac{T_2}{T_1}\right)V_1 = \left(\frac{1\,atm}{8.95\,atm}\right)\left(\frac{270K}{293K}\right)(12.57\,m^3)$

$= 1.29\ m^3$ ($1.16\,m^3$ if $-30°C$ is used)

c) If we want to maintain Volume $V_2 = 12.57\,m^3$, we must add more air, to make up $\Delta V = (12.57 - 1.29\,m^3) = 11.28\,m^3$ (11.44 if -3[illegible])

$pV = nRT$

so $n = \frac{pV}{RT} = \frac{(8.95\,atm)(1.01 \times 10^5\ Pa/atm)(11.28\,m^3)}{(8.31\ J/mol\,K)(270K)} = 4.55 \times 10^3\ mol$

(5.10×10^3 mol @ -30K)