Group work problem on planets & atmospheres

$v_{esc} = \sqrt{\frac{2GM}{R}}$ $\quad m_H \cong m_p = 1.67 \cdot 10^{-27}\,kg$

$m_{O_2} \cong 32 m_p = 5.34 \cdot 10^{-26}\,kg$

$v_{rms} = \sqrt{\frac{3kT}{m}}$

planet	v_{esc}	v_H (km/s)	v_{O_2}	liquid H_2O?	life conditions?
β pic	36.5	3.15	0.56	✓	H wouldn't escape easily
51 peg	20.0	2.59	0.46	~	"
ρ^1 Oph	338	2.68	0.47	✓	good
α Canis	3.48	3.89	0.68	✓	good

Group Problem

$T_1 = 5.0\,^\circ C$ $\quad T_2 = 45.0\,^\circ C$

$P_{2\,gauge} = ?$

$V_1 = 0.0150\,m^3$

$V_2 = 0.0159\,m^3$

$P_{1\,gauge} = 1.70\,atm$

$P_{ambient} = 1.02\,atm$

$P_1 = 1.70 + 1.02 = 2.72\,atm$

$\frac{PV}{T} = NK = \text{constant} \rightarrow \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$P_2 = P_1 \frac{V_1}{V_2} \frac{T_2}{T_1} = 2.72\,atm \left(\frac{0.0150\,m^3}{0.0159\,m^3}\right)\left(\frac{318\,K}{278\,K}\right) = 2.94\,atm$

$P_{2\,gauge} = P_2 - P_{ambient} = 294 - 1.02 = \boxed{1.92\,atm}$

Balloon problem

i) How much volume does a single canister of compressed H expand to when released to atmospheric P?

ii) How many canisters of released H to fill the balloon?

i) $PV = NkT = \text{constant} \rightarrow P_1 V_1 = P_2 V_2$

$V_2 = V_1 \, P_1/P_2 = \frac{1.30 \cdot 10^6\,Pa}{1.01 \cdot 10^5\,Pa}\, 1.90\,m^3 = 24.46\,m^3$

ii) $n_{canisters} = \frac{V_{balloon}}{V_2} = \frac{750\,m^3}{24.46\,m^3} = 30.7$ cylinders