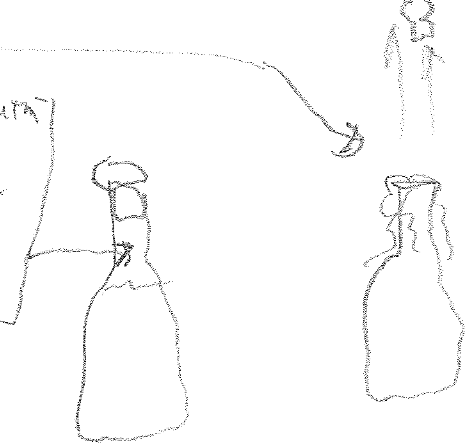
19-58

$p_2 = 1.00$ atm $\qquad$ $p_1 = 5.00$ atm

$T_2 = ?$ $\qquad$ $T_1 = 5.00$c

$V_2 = ?$ $\qquad$ $V_1 = ?$

$n = ?$ ⟵ same ⟶ $n = ?$



Expands adiabaticly,

Such That $p_1 V_1^{\gamma} = p_2 V_2^{\gamma}$, $\gamma = 4/3$

also, an ideal gas so $pV = nRT$

Solve for V since we dont know either V and want to eliminate it: $V = \frac{nRT}{p}$

substi $\quad p_1 \left(\frac{nRT_1}{p_1}\right)^{\gamma} = p_2 \left(\frac{nRT_2}{p_2}\right)^{\gamma}$

nR same, eliminate, bring $\left(\frac{1}{p_1}\right)^{\gamma}$ out,

$$p_1^{1-\gamma} T_1^{\gamma} = p_2^{1-\gamma} T_2^{\gamma}$$

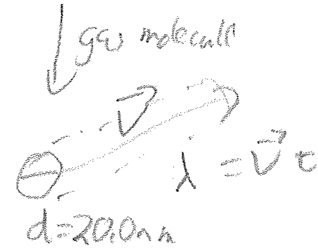
solve for $T_2 = \left(\left(\frac{p_1}{p_2}\right)^{1-\gamma} T_1^{\gamma}\right)^{1/\gamma}$

$$= \left(\frac{p_1}{p_2}\right)^{\frac{1-\gamma}{\gamma}} T_1 = \left(\frac{5.00\text{ atm}}{1.00\text{ atm}}\right)^{\frac{1-4/3}{4/3}} (278\text{K})$$

$$= 186\text{K} = -87°\text{C}$$

So it is really cold.

19-68 $T = 50.0\,K$, $p = 1.0\times10^{-8}\,Pa$



What's mean free path of molecule of gas in interstellar space?

as shown on p. 514-5, we see how long it takes to sweep out a volume of space big enough to hold one other molecule, get eq. 19-25 $\lambda = \frac{1}{\sqrt{2}\pi d^2 N/V}$

$pV = nRT = NkT$, so $\frac{N}{V} = \frac{p}{kT}$

subst: $\lambda = \frac{kT}{\sqrt{2}\,p\pi d^2} = \frac{(1.38\times10^{-23}\,J/K)(50.0\,K)}{\sqrt{2}(1.0\times10^{-8}\,Pa)\,\pi\cdot(20\times10^{-9})^2}$

$= 38.8\,m$

How long between collisions?

a molecule takes $t = \frac{\lambda}{v}$ to travel λ,

and $v_{rms} = \sqrt{\frac{3kT}{m}}$ what's m? oops, didn't provide it, but H_2 is most common molecule in space, so $M = 2\,amu$

$t = \frac{38.8\,m}{\sqrt{\frac{3\cdot 1.38\times10^{-23}\cdot 50}{2\cdot 1.66\times10^{-27}}}} = 25\,m/s$