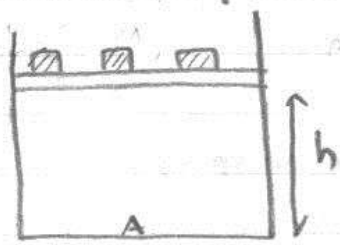
January 2000 SM # 2

adiabatic piston and walls $\Rightarrow S = \text{const}$, $PV^\gamma = \text{const} = G$



Let M = total mass on the piston

$Mg = (P - P_0)A$

$Mg = AV^{-\gamma}G - P_0 A \quad V = Ah$

$Mg = A(Ah)^{-\gamma}G - P_0 A$

Let P_0 = the pressure at a height h_0 when there are no masses on the piston.

$P_0 (Ah_0)^\gamma = G$

$\Rightarrow Mg = A(Ah)^{-\gamma} P_0 (Ah_0)^\gamma - P_0 A$

$M = \frac{P_0 A}{g}\left[\left(\frac{h}{h_0}\right)^{-\gamma} - 1\right]$

$= M_0 + M(h), \quad M(h) \propto h^{-n}$

$n = \gamma = \frac{D+2}{D}$ where D = # of degrees of freedom of the gas

for N_2 $D = 5 \Rightarrow n = \frac{7}{5}$

$M_0 = -\frac{P_0 A}{g}$