5.1) a) Compression is approximately adiabatic

$$TV^{\gamma-1} = \text{const}$$

$$T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1}$$

$$T_f = T_i \left(\frac{V_i}{V_f} \right)^{\gamma-1} \qquad T_i = 300\,K \Rightarrow T_f = 994\,K$$

b) T_f is above ignition temperature of Diesel-air mixture

5.2. a) $\delta W_V = -(p - p_0)\, dU = -(p-p_0)\, 4\pi a^2\, da$

b) $\delta W_A = \sigma\, dA = \sigma\, 8\pi a\, da$

c) $|\delta W_V| = |\delta W_A|$ equilibrium condition

$$(p-p_0)\, 4\pi a^2\, da = \sigma\, 8\pi\, a\, da$$

$$p - p_0 = \frac{2\sigma}{a}$$

5.3) a) $F \sim T$ at fixed L

b) at fixed F, L increases with decreasing T and vice versa

4a) $p = \frac{Mg}{A}$

b) $\left.\begin{aligned} pV_0 &= pAz_0 = Nk_BT_0 \\ pV &= pAz = Nk_BT \end{aligned}\right\} \rightarrow \frac{T}{T_0} = \frac{z}{z_0}$

$T = 2T_0$

c) $W = \int p\,dV = \frac{Mg}{A}\Delta V = \frac{Mg}{A} A z_0 = Mgz_0$

d) $\Delta U = \frac{3}{2} Nk_BT - \frac{3}{2} Nk_BT_0 = \frac{3}{2} Nk_BT_0$

e) $Q = \Delta U + |W| = \frac{3}{2} Nk_BT_0 + Mgz_0$

$= \frac{3}{2} Nk_BT_0 + Nk_BT_0$

$= \frac{5}{2} Nk_BT_0$