Exercise 1.37: For a adiabatic process with diatomic gas $VT^{5/2}$ is constant. Note that $V_i T_i^{5/2} = V_f T_f^{5/2} = \frac{V_i}{20} T^{5/2}$ thus $T_f = T_i \cdot 20^{2/5} \approx 975K \approx 1295°F$ since we get auto ignition at $410°F$, we need no spark plug.

Exercise 1.40: (a) Since we know that $V = \frac{NkT}{P}$ we can write $dV = Nk(\frac{1}{P}dT - \frac{T}{P^2}dP)$. Note that $dU = -PdV = Nk(-dT + \frac{T}{P}dP)$ and that $dU = \frac{f}{2}NkdT$, thus $\frac{f}{2}NkdT = Nk(-dT + \frac{T}{P}dP)$ or simplified $\frac{dT}{dP} = \frac{2T}{(f+2)P}$.

(b) Note that $\frac{dT}{dz} = \frac{dT}{dP}\frac{dP}{dz} = \frac{2T}{(f+2)P}\frac{-mgP}{kT} = \frac{-2mg}{(f+2)k}$.

Exercise 1.41: (a) Water has a specific heat of 4.186 joule/gram K. Our waters heat capacity is 1046.5 joule/K. Thus we gained 4186 joule of heat.

(b) By conservation of energy the metal lost 4186 joule.

(c) Heat capacity is $\frac{Q}{\Delta T} = \frac{-4186}{-76} = 55.079$joule/K.

(d) Specific heat is .55079 joule/gram K.