Thermodynamics Assessment 2

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November 6, 2012

General feedback

- Assessment was generally done very well.
- Some problems understanding the 2^{nd} law in parts (a) and (i).
- If you have any questions, bring them along to the next tutorial or send me an email.

Question specific points

(a) Most people understood first law and used it correctly. Some however used a different convention than that of this course, beginning with $dU = dQ - dW$ which led to some confusion. We use $dU = dQ + dW$, where dQ is the heat supplied TO the system and dW is the work done ON the system.

Very few people got (a) part (ii) correct, with most quoting KP and Clausius versions of the 2^{nd} law and making statements such as "no heat flows from cold to hot thus second law is satisfied". In this problem we had multiple bodies, so the simplest approach is to start from the Clausius inequality, which is easily seen to be violated. Alternative valid methods used by some students were to add engines to the system so as to construct a composite system which then violates one of Clausius/KP; or to look at the efficiency of the composite compared to an equivalent system of Carnot engines.

(b) Well done.

(c) Many students started with the expansion seen in a previous problem set then plugged in the ideal gas law to get the final answer. This "works" but requires you to essentially replace a PV term on the RHS of the equation despite their already being a PV on the LHS which is clearly not that of an ideal gas! For full marks you needed to follow the hint and perform the expansion fully.

(d) Well done. Some students confused about signs of coefficients a and b, and some thought that these were functions of temperature – they are material-dependent constants.

(e) and (f) Well done EXCEPT many students seemed to think $\frac{1}{T_f - T_i} = \frac{1}{T_f} - \frac{1}{T_i}$. NO!

(g) Good, many students did not answer the last part though. Entropy is a state function, thus since taking any substance once round a cycle returns it to the same (initial) state, there can be no change in it's entropy.

(h) OK. One common problem was obtaining an expression of heat q for the constant pressure process, writing $q = \int C_p dT = C_p \Delta T$. However, in part (e), or just from $C_p = (\frac{dH}{dT})_p$, we find that C_p is a function of T and can't be taken outside of the integral.

(i) OK. Some did not realise that Universe = substance + surroundings (i.e. EVERYTHING). Thus $\Delta S_{universe} = \Delta S_{substance} + \Delta S_{surroundings} = \Delta S_{surroundings}$ since in (g) you have proven that their is no entropy change for the substance going round the cycle. The final step is to realise that in the case of the surroundings, the process is the same as in (h) but with the heat flows reversed, and thus $\Delta S_{universe} = -\sum_i \frac{q_i}{T_{res_i}} > 0$ from (h).

Mark distribution

Average mark $= 15.5/20$

Histogram: