In each case calculate the amount of heat for constant pressure cooling of isobutane from 1 bar, 300 K to 250 K, and the entropy generation if cooling takes place inside a bath at $T_{\text{bath}} = 240$ K. The following data are available:

| $T$( K) | $P$ (bar) | $H^R$ (J/mol) | $S^R$ (J/mol K) |
|---|---|---|---|
| 400 | ~~0.0002~~ 20 | −2562.44 | −4.63942 |
| 300 | 1 ~~0.00001~~ | −163.626 | −0.352764 |
| 250 | 1 ~~0.00001~~ | −23224.5 | −87.0989 |
| | $C_P^{\text{ig}} = 96.5$ J/mol | | |

**Problem 5.16:** Use the Lee-Kesler method to do the following:
a) Calculate the entropy of propane at its critical point. The reference state is the ideal-gas state at the critical point.
b) Calculate $\Delta S$ of propane for an isothermal process that takes the substance from its critical point to pressure 1 Pa.
c) A member of our engineering team objects that the reference state is not valid because a substance is not ideal at the critical point. What is your response?

**Problem 5.17:** The steam tables are calculated with reference state the saturated liquid at the triple point ($P_{\text{triple}} = 0.006117$ bar, $T_{\text{triple}} = 0.01$ °C). Suppose we want to retabulate the properties of steam using a different reference state. Show how this can be done by calculating $V$, $U$, $H$, and $S$ at 1 bar, 200 °C using the following reference states:
a) the saturated vapor at 10 bar;
b) the saturated vapor in the hypothetical ideal-gas state at 10 bar.
Additional data: The ideal-gas heat capacity of water is given by the following equation with $T$ in kelvin.

$$C_P^{\text{ig}}/R = 4.395 - 0.004186\,T + 0.00001405\,T^2 - 1.564 \times 10^{-8}\,T^3 + 6.32 \times 10^{-12}\,T^4.$$