[tex32] Joule−Thomson coefficient of van der Waals gas

The cooling of a gas via throttling is described by the Joule-Thomson coefficient

$$\left(\frac{\partial T}{\partial p}\right)_E = \frac{1}{C_p}\left[T\left(\frac{\partial V}{\partial T}\right)_p - V\right].$$

(i) Determine the Joule-Thomson coefficient for 1 mol of the van der Waals gas $[(p+a/V^2)(V-b) = RT, C_V = \alpha R]$.
(ii) Throttling results in cooling only if $(\partial T/\partial p)_E > 0$. In the (T,p)-plane, this region is bounded by the inversion curve, which is determined by the condition $(\partial T/\partial p)_E = 0$. Calculate the inversion condition $p^*(T)$ for the van der Waals gas.
(iii) Throttling is most efficient for cooling if it starts at the highest possible pressure. Find the temperature at which the inversion curve has a maximum.

Solution: