

Thermal Physics PHY474 Lab #5: Van der Waals Equation of State

We study the van der Waals isotherms. We write the equation of state using the scaled variables (law of corresponding states) T/T_C , p/p_C , v/v_C . In terms of the scaled variables the critical isotherm is $T = 1$, and the critical point is $p = 1$ and $v = 1$.

$$v := .334, .335 \dots 5$$

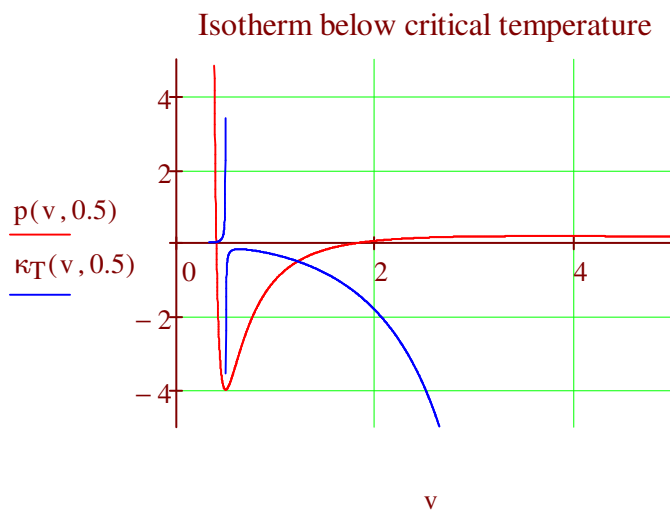
$$p(v, T) := 8 \cdot \frac{T}{3 \cdot v - 1} - \frac{3}{v^2}$$

This is the equation of state.

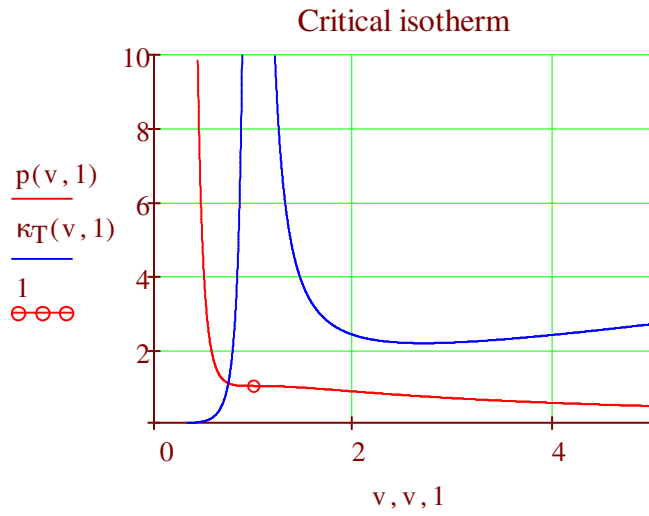
$$\kappa_T(v, T) := \left[24 \cdot \frac{T \cdot v}{(3 \cdot v - 1)^2} - \frac{6}{v^2} \right]^{-1}$$

This is the isothermal compressibility in units of $1/p_C$. **Assignment:** Prove this formula.

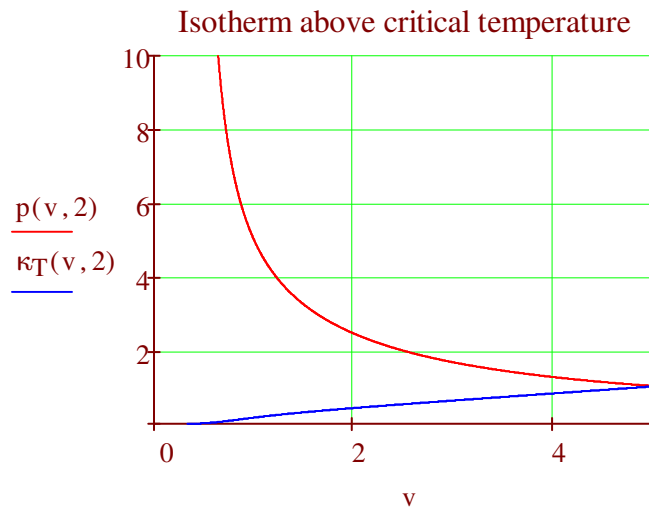
We graph isotherms for $T = 0.5, 1$, and 2 , plotting p and κ_T versus v .



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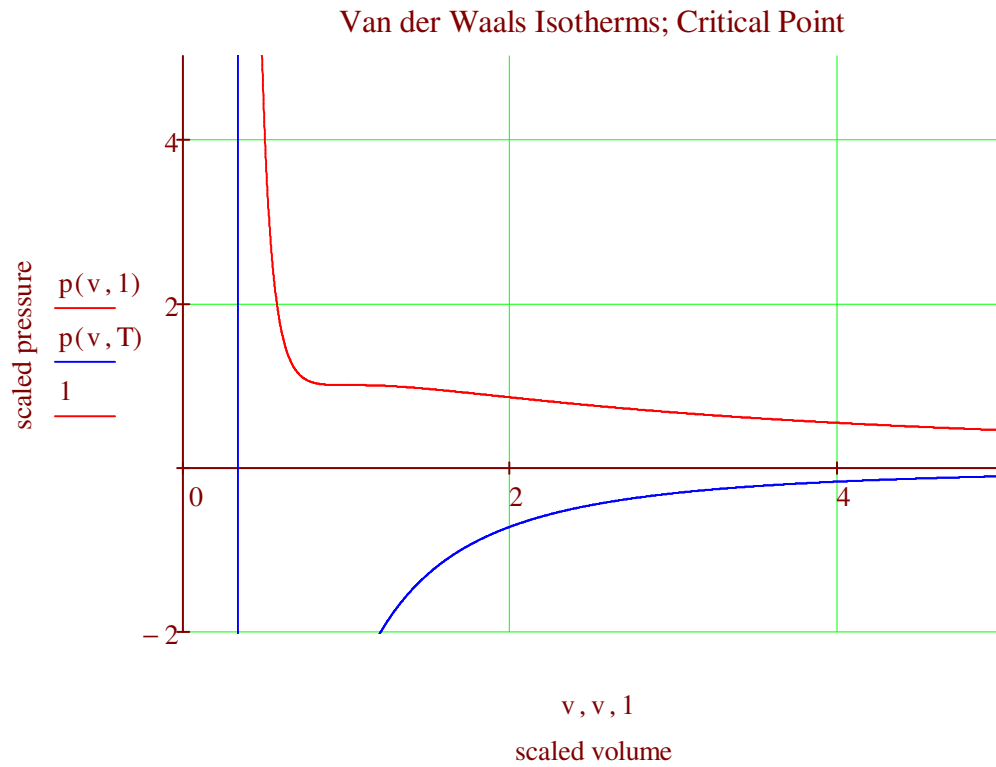


The critical isotherm, at the critical point, is horizontal: the slope $(dp/dv)_T = 0$.
 What is the value of the isothermal compressibility at the critical point?



We now produce an animation of the van der Waals isotherms.

$$T := \frac{\text{FRAME} + 1}{50}$$



Video Clip