1. The Joule-Thomson coefficient represents how the temperature of a gas changes under an isenthalpic (constant enthalpy) expansion. It is defined as $\mu_{\mathrm{JT}} \equiv \left(\frac{\partial T}{\partial P}\right)_H$

   (a) Starting from a total differential of enthalpy $H(T, P)$, derive this equivalent form:

$$\mu_{\mathrm{JT}} \equiv \left(\frac{\partial T}{\partial P}\right)_H = -\frac{1}{C_P}\left(\frac{\partial H}{\partial P}\right)_T$$

   (b) Derive the same expression, but use a triple product rule.

2. A real gas obeys an equation of state:

$$V = \frac{RT}{P} + b$$

Given $b = 0.02\,\text{L/mol}$, use Joule–Thompson to determine whether the gas cools or heats during an isenthalpic expansion. You can use your result from Activity 21 Problem 1.

3. Show that the Joule-Thompson coefficient can be written as:

$$\mu_{\text{JT}} \equiv -\frac{1}{C_P}\left(\frac{\partial H}{\partial P}\right)_T = -\frac{1}{C_P}\left[\left(\frac{\partial U}{\partial V}\right)_T\left(\frac{\partial V}{\partial P}\right)_T + \left(\frac{\partial (PV)}{\partial P}\right)_T\right]$$

Homework Problem 22

1. Starting from the first law, show that:

$$T\,dS = c_V\,dT + \left(\left(\frac{\partial U}{\partial V}\right)_T + P\right)dV$$