1. **(a)** A pure nitrogen ideal gas is within a cylinder of volume, 0.04 m^3 at a pressure of 150 bars and temperature of 20°C. What is the mass (in kg) of the gas?
(b) Suppose, for the sake of safety, you want to ensure that the interior pressure does not exceed 150 bars. You install a plug that will melt at a certain temperature so that the gas can escape if the pressure exceeds this value. At what temperature (in °C) should the plug melt?

2. For the *Berthelot* Equation of State (see #5 on Phy 372 home page):
(a) Expand P in terms of v and T, i.e. start with dP and express it in terms of dv and dT. (Here v is the molar specific volume.) Rewrite the expansion with the coefficients evaluated. These coefficients will be functions of v and T.
(b) Use the cyclic relation to find an expression for $\frac{\partial v}{\partial T}|_P$.
(c) Write an expression for β. The result will again be a function of v and T.
(d) Show that, if $b = 0$, then

$$\beta = \frac{1}{T}\left(\frac{RvT^2 + a}{RvT^2 - 2a}\right) \tag{1}$$

This result makes it clear that if both b and a are zero, then $\beta = 1/T$ which is the value for the ideal gas.

3. Show that κ_T for the Dieterici Equation of State when $b = 0$ is

$$\kappa_T = \frac{1}{P}\frac{1}{\left(1 - \frac{a}{RTv}\right)} \tag{2}$$

Do you expect $a < RTv$ or $a > RTv$? Explain.

4. A substance is studied in the lab for which the following response functions are found:

$$\beta = \frac{bT^2}{P} \qquad \text{and} \qquad \kappa_T = \frac{aT^3}{P^2} \tag{3}$$

where a and b are constants that have units of $(N/m^2)/K$. Assume that an equation of state *can* be found and find it. Also, find the ratio of a/b.

5. In the lab, the following response functions are found:

$$\beta = \frac{2bT}{v} \qquad \kappa_T = \frac{aT}{v} \tag{4}$$

where a and b are constants and v is the molar specific volume. Use the method of mixed partial derivatives to determine whether an equation of state can be found. If so, find it.