The Isothermal Bulk Modulus

We have the following equations of state for a *monatomic ideal gas*. The first is the famous ideal gas law. The second is the internal energy of a *monatomic* ideal gas. The third is the Sackur-Tetrode equation for entropy, which is true for any ideal gas.

$$pV = Nk_BT$$

$$U = \frac{3}{2}Nk_BT$$

$$S = Nk_B\left\{\ln\left[\frac{V}{N}\left(\frac{mU}{3\pi N\hbar^2}\right)^{\frac{3}{2}}\right] + \frac{5}{2}\right\}$$

Using the above equations, find the isothermal bulk modulus, which you can think of them as an *intensive* spring constant for a three-dimensional material. The Isothermal Bulk Modulus is

$$b_T = -V\left(\frac{\partial p}{\partial V}\right)_T$$

Now find the *adiabatic* bulk modulus, which involves holding the *entropy* constant:

$$b_S = -V\left(\frac{\partial p}{\partial V}\right)_S$$

by David Roundy