Another mechanical parameter

First volume:

$$V(T,p,N,m) = \frac{Nk_BT}{p}$$

whence

$$\left.\frac{\partial V}{\partial m}\right)_{T,p,N} = 0$$

Then entropy:

$$S(E,V,N,m) = k_BN\left[\tfrac{3}{2}\ln\left(\frac{4\pi mEV^{2/3}}{3h_0^2N^{5/3}}\right) + \tfrac{5}{2}\right],$$

but use

$$E = \tfrac{3}{2}Nk_BT \quad \text{and} \quad V = \frac{Nk_BT}{p}$$

to write

$$S(T,p,N,m) = k_BN\left[\tfrac{3}{2}\ln\left(\frac{2\pi mk_B^{5/3}T^{5/3}}{3h_0^2p^{2/3}}\right) + \tfrac{5}{2}\right].$$

In other words (abusing the notation to allow the logarithm of a variable with dimensions),

$$S(T,p,N,m) = k_BN\left[\tfrac{3}{2}\ln(m) + \text{ stuff independent of } m\ \right],$$

whence

$$\left.\frac{\partial S}{\partial m}\right)_{T,p,N} = \tfrac{3}{2}\frac{k_BN}{m}.$$

Experiment: Compare $V(T,p,N,m)$ and $S(T,p,N,m)$ for a series of (nearly) ideal monatomic gases such as He, Ne, Ar, Kr, Xe that differ in mass.