5.22 The chemical potential of an ideal gas was worked out in Eqn 3.63 (pp 118) and found to be:

\[ \mu = -kT \ln \left( \frac{V}{N} \left( \frac{2\pi m kT}{\hbar^2} \right)^{3/2} \right) \]

\[ = -kT \ln \left( \frac{2\pi m kT}{\hbar^2} \right)^{3/2} - kT \ln \left( \frac{V}{N} \right) \]

but \( \frac{V}{N} = \frac{kT}{P} \) for an ideal gas.

So,

\[ \mu = -kT \ln \left( \frac{2\pi m kT}{\hbar^2} \right)^{3/2} - kT \ln \left( \frac{kT}{P} \right) \]

Now \( \mu^0 \), in the same with \( P \) replaced by \( P^0 \)

\[ \Rightarrow \mu - \mu^0 = -kT \ln \left( \frac{2\pi m kT}{\hbar^2} \right)^{3/2} - kT \ln \left( \frac{kT}{P} \right) \]

\[ + kT \ln \left( \frac{2\pi m kT}{\hbar^2} \right)^{3/2} + kT \ln \left( \frac{kT}{P^0} \right) \]

\[ = kT \ln \left( \frac{P}{P^0} \right) \]

\[ \Rightarrow \mu = \mu^0 + kT \ln \left( \frac{P}{P^0} \right) \]