8.3: Isothermal Expansion of an Ideal Gas

An ideal gas obeys the equation of state $PV = RT$ ($V = \text{molar volume}$), so that, if a fixed mass of gas kept at constant temperature is compressed or allowed to expand, its pressure and volume will vary according to $PV = \text{constant}$. That is, Boyle's Law. We can calculate the work done by a mole of an ideal gas in a reversible isothermal expansion from volume $V_1$ to volume $V_2$ as follows.

$$ W = \int_{V_1}^{V_2} P \, dV = R \, T \int_{V_1}^{V_2} \frac{dV}{V} = R \, T \ln \left( \frac{V_2}{V_1} \right) $$