Suppose that a piston encloses a monatomic ideal gas that starts at a state (1) having a gauge pressure of 2.0 atm, a temperature of 27°C, and a volume of 10 L.

A. Find the number of moles of the ideal gas.

Caution! Need absolute pressures and temperatures!

\[ p_1 = 2\text{ atm} + 1\text{ atm} = 3\text{ atm} \]
\[ T_1 = 27\degree C + 273 = 300\text{ K} \]

\[ p_1V_1 = nRT_1 \]
\[ n = \frac{p_1V_1}{RT_1} = \frac{(3\text{ atm})(10\text{ L})}{(0.08207\text{ atm L/mole K})(300\text{ K})} \]
\[ n = 1.22 \text{ moles} \]

B. If the gas undergoes an isobaric expansion to state (2) having volume of 20 L, find the temperature at state (2). (The number of moles does not change.)

\[ p_2V_2 = nRT_2 \]
\[ V_2 = 20\text{ L} \]
\[ p_2 = p_1 = 3\text{ atm} \text{ (isobaric)!} \]

\[ T_2 = \frac{p_2V_2}{nR} = \frac{(3\text{ atm})(20\text{ L})}{(1.22\text{ moles})(0.08207\text{ atm L/mole K})} \]
\[ T_2 = 599\text{ K} = T_2 \]

C. Draw the process on a "pV" diagram and find the work done by the gas on the piston.

\[ p = 3\text{ atm} \]
\[ V_1 = 10\text{ L} \]
\[ V_2 = 20\text{ L} \]

Work = Area under pV "curve"

\[ W = \int_{V_1}^{V_2} p\,dV = \text{Area under pV curve} \]

\[ W = (20\text{ L} - 10\text{ L})(3\text{ atm}) = 30\text{ atm L} \]

\[ R = 0.08207\text{ atm L/mole K} \]
\[ T_k = T_c + 273 \]
\[ pV = nRT \]
\[ W = \int_{V_1}^{V_2} p\,dV = \text{Area under pV curve} \]