Chapter 18 Problem 22 [†]

Given
$n = 0.30\ mol$
$T = 300\ K$
$V_f = 5V_i$

Solution
Find the work done during the isothermal expansion.

Work done by an idea gas is

$$W = \int_{V_i}^{V_f} PdV$$

However, pressure is a function of volume as determined by the ideal gas law.

$$P = \frac{nRT}{V}$$

Therefore, work becomes

$$W = \int_{V_i}^{V_f} \frac{nRT}{V} dV = nRT \ln\left(\frac{V_f}{V_i}\right)$$

Substituting in the given values

$$W = (0.30\ mol)(8.31\ J/mol \cdot K)(300\ K) \ln\left(\frac{5V_i}{V_i}\right)$$

$$W = 1204\ J = 1.2\ kJ$$

[†]Problem from Essential University Physics, Wolfson