Chapter 18   Problem 32 [†]

Given

$W = 3.3 \ kJ = 3300 \ J$
$V_f = 10V_0$
$T = 440 \ K$

Solution

a) Find the heat absorbed by the gas.

Begin with the first law of thermodynamics.

$$\Delta U = Q + W$$

Since the temperature stays constant, $\Delta U = 0$. Therefore,

$$Q = -W$$

The work done by the gas is 3300 J because it is expanding. However, the work done on the gas is $-3000 \ J$, which is how W is defined. Therefore,

$$Q = -(-3000 \ J) = 3000 \ J$$

b) Find the number of moles of gas.

Since this is an isothermal process, the work done is

$$W = -nRT \ln\left(\frac{V_2}{V_1}\right)$$

Solving for n gives

$$n = \frac{W}{-RT \ln\left(\frac{V_2}{V_1}\right)}$$

Substitute in the appropriate values gives

$$n = \frac{-3300 \ J}{-(8.31 \ J/mol \cdot K)(440 \ K) \ln\left(\frac{10V_0}{V_)}\right)} = 0.39 \ mol$$

[†]Problem from Essential University Physics, Wolfson