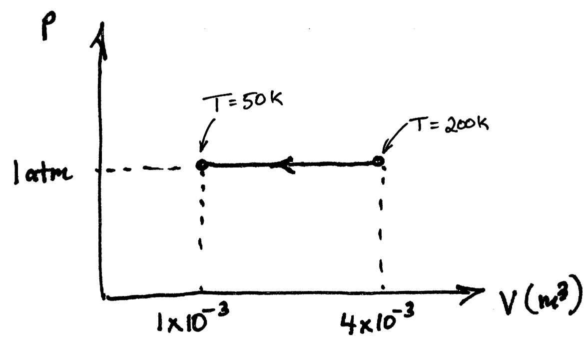
SOLUTION

Physics 11 **Quiz 2** **Spring 2009**

A monatomic, ideal gas undergoes the compression shown below. The initial temperature is 200K and the final temperture is 50K.



Use 1 atm = $1. \times 10^5$ Pa and recall $U = \frac{3}{2}nRT$, where R=8.314 J/mol·K

For the process shown:

(a) How much work is done *on* or *by* the gas?

(b) What is the change in internal energy of the gas?

(c) How much heat goes *in* or *out* of the gas?

(a) Work is done on the gas since it is compressed:

$$W = \int pdV = p\Delta V = \left(1 \times 10^5 \text{ Pa}\right)\left(1 \times 10^{-3}\text{m}^3 - 4 \times 10^{-3}\text{m}^3\right) = \boxed{\text{-300 J}}$$

The negative sign indicates work done on the gas.

(b) We will need the number of moles of gas to compute the internal energy change:

$$n = \frac{pV}{RT} = \frac{(1 \times 10^5 \text{ Pa})(4 \times 10^{-3}\text{m}^3)}{(8.314\text{J/mol}\cdot\text{K})(200 \text{ K})} = 0.24 \text{ mol}$$

Now use the internal energy of monatomic ideal gas:

$$\Delta U = \frac{3}{2}nR\Delta T = \frac{3}{2}(0.24 \text{ mol})(8.314\text{J/mol}\cdot\text{K})(50 \text{ K} - 200 \text{ K}) = \boxed{\text{-449 J}}$$

(c) Use the first law of thermodynamics:

$$\Delta U = Q - W$$

$$\longrightarrow Q = \Delta U + W = -449 \text{ J} + (-300 \text{ J}) = \boxed{\text{-749 J}}$$