

53. (a) Since the process is at constant pressure energy transferred as heat to the gas is given by  $Q = nC_p \Delta T$ , where  $n$  is the number of moles in the gas,  $C_p$  is the molar specific heat at constant pressure, and  $\Delta T$  is the increase in temperature. For a diatomic ideal gas  $C_p = \frac{7}{2}R$ . Thus

$$Q = \frac{7}{2}nR \Delta T = \frac{7}{2}(4.00 \text{ mol})(8.31 \text{ J/mol} \cdot \text{K})(60.0 \text{ K}) = 6.98 \times 10^3 \text{ J} .$$

- (b) The change in the internal energy is given by  $\Delta E_{\text{int}} = nC_V \Delta T$ , where  $C_V$  is the specific heat at constant volume. For a diatomic ideal gas  $C_V = \frac{5}{2}R$ , so

$$\Delta E_{\text{int}} = \frac{5}{2}nR \Delta T = \frac{5}{2}(4.00 \text{ mol})(8.31 \text{ J/mol} \cdot \text{K})(60.0 \text{ K}) = 4.99 \times 10^3 \text{ J} .$$

- (c) According to the first law of thermodynamics,  $\Delta E_{\text{int}} = Q - W$ , so

$$W = Q - \Delta E_{\text{int}} = 6.98 \times 10^3 \text{ J} - 4.99 \times 10^3 \text{ J} = 1.99 \times 10^3 \text{ J} .$$

- (d) The change in the total translational kinetic energy is

$$\Delta K = \frac{3}{2}nR \Delta T = \frac{3}{2}(4.00 \text{ mol})(8.31 \text{ J/mol} \cdot \text{K})(60.0 \text{ K}) = 2.99 \times 10^3 \text{ J} .$$