Solution

The volume of 4 g helium at $0°C$ temperature and a pressure of 100 kPa is 22.4 dm^3 (molar volume). It follows that initially the pressure on the left hand side is 600 kPa, on the right hand side 100 kPa. Therefore the valve is closed.

An adiabatic compression happens until the pressure in the right side reaches 600 kPa ($\kappa = 5/3$).

$$100 \cdot 11.2^{5/3} = 600 \cdot V^{5/3},$$

hence the volume on the right side (when the valve opens):

$$V = 3.82 \text{ dm}^3.$$

From the ideal gas equation the temperature is on the right side at this point

$$T_1 = \frac{pV}{nR} = 552\text{K}.$$

During this phase the whole work performed increases the internal energy of the gas:

$$W_1 = (3.15 \text{ J/gK}) \cdot (2 \text{ g}) \cdot (552 \text{ K} - 273 \text{ K}) = 1760 \text{ J}.$$

Next the valve opens, the piston is arrested. The temperature after the mixing has been completed:

$$T_2 = \frac{12 \cdot 273 + 2 \cdot 552}{14} = 313\text{K}.$$

During this phase there is no change in the energy, no work done on the piston.

An adiabatic compression follows from 11.2 + 3.82 = 15.02 dm^3 to 11.2 dm^3:

$$313 \cdot 15.02^{2/3} = T_3 \cdot 11.2^{2/3},$$

hence

$$T_3 = 381 \text{ K}.$$

The whole work done increases the energy of the gas:

$$W_3 = (3.15 \text{ J/gK}) \cdot (14 \text{ g}) \cdot (381 \text{ K} - 313 \text{ K}) = 3000 \text{ J}.$$

The total work done:

$$W_{total} = W_1 + W_3 = 4760 \text{ J}.$$

The work done by the outside atmospheric pressure should be subtracted:

$$W_{atm} = 100 \text{ kPa} \cdot 11.2 \text{ dm}^3 = 1120 \text{ J}.$$

The work done on the piston by us:

$$W = W_{total} - W_{atm} = \mathbf{3640\ J}.$$