A gas is compressed from an initial volume of 5.70 L to a final volume of 1.23 L by an external pressure of 1.00 atm. During the compression the gas releases 120 J of heat. What is the change in internal energy of the gas?

Solution:

According to the first law of thermodynamics, change in the internal energy of gas is equal to the **energy added as heat to the system plus the work done on the system by its surroundings**:

$\Delta U=\Delta Q+\Delta W$;

We can substitute ΔW in the equation above by $p\Delta V$, where p –pressure, ΔV – change of volume, so we get:

$\Delta U=\Delta Q + p\Delta V$;

Substituting variables for numbers, we get:

$\Delta U= -120J + 1.00 * 101325\ Pa * ((5.7 - 1.23)*10^{-3}\ m^3) = -120\ J + 101325\ Pa * 0.00447\ m^3 = -120\ J + 452.92\ J = 332.92\ J$

(We converting pressure to Pascal's for matching units because [Pa] = [N/m^2] and multiplying them by m^3 we get [N*m], which is equal to Joules by definition. The Q value was taken with the minus sign, because heat is released by the system).

Answer:

Change in internal energy of the gas is +332.92 J.