10 moles of an ideal monatomic gas expand from 1.000 m\(^3\) to 1.001 m\(^3\) doing 100 J of work.

(a) Find the change in internal energy of the gas when the expansion is adiabatic (no heat flow).
\[ \Delta U = Q - W_{\text{done}} \]
\[ Q = 0 \quad W = 100 \text{ J} \]
\[ \Delta U = -100 \text{ J} \]

Suppose instead that the expansion is at constant pressure.

(b) What is the pressure?
\[ W_{\text{done}} = P \Delta V \]
\[ \Delta V = 1.001 \text{ m}^3 - 1.000 \text{ m}^3 = 0.001 \text{ m}^3 \]
\[ (100 \text{ J}) = P (0.001 \text{ m}^3) \]
\[ P = 1.00 \times 10^5 \text{ Pa} \]

(c) What is the change in temperature?
\[ PV = nRT \quad P \text{ constant} \]
\[ P \Delta V = nR \Delta T \]
\[ 100 \text{ J} = (10 \text{ mol}) (8.31 \text{ J/molK}) \Delta T \]
\[ \Delta T = 1.21 \text{ K} \]

(d) What is the change in internal energy of the gas?
\[ U = \frac{3}{2} nRT \]
\[ \Delta U = \frac{3}{2} nR \Delta T \]
\[ = \frac{3}{2} P \Delta V \]
\[ = \frac{3}{2} (100 \text{ J}) \]
\[ \Delta U = 150 \text{ J} \]

(e) What is the flow of heat?
\[ \Delta U = Q - W \]
\[ 150 \text{ J} = Q - 100 \text{ J} \]
\[ Q = 250 \text{ J} \]