

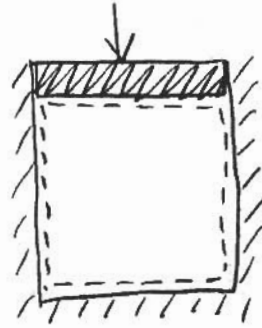
SOLUTIONS TO T4 (WAITZ)

a) QUASI-STATIC, ADIABATIC COMPRESSION

$$P_1 = 100 \text{ kPa}, \quad P_2 = 500 \text{ kPa}$$

$$T_1 = 300 \text{ K}$$

$$V_1 = \frac{287 \cdot 300}{100,000} = 0.861 \frac{\text{m}^3}{\text{kg}}$$



$$PV^\gamma = \text{CONST. (FOR WHOLE PROCESS)} \quad \frac{P_2}{P_1} = \left(\frac{V_1}{V_2}\right)^\gamma \quad 5 = \left(\frac{0.861}{V_2}\right)^{1.4}$$

$$\therefore \boxed{V_2 = 0.273}$$

$$T_2 = \frac{500,000 \cdot 0.273}{287} = \boxed{475 \text{ K}}$$

$$\Delta u = \cancel{q} - w \quad \Delta u = -w, \quad C_v \Delta T = -w$$

$$w = -716.5(475 - 300) = \boxed{-125 \text{ kJ/kg}}$$

BY THE SYSTEM - NEGATIVE  
SINCE ENERGY TRANSFERRED  
TO SYSTEM.

b) INITIAL STATE IS THE SAME.

KNOW  $P_f = 500 \text{ kPa}$  BUT DON'T KNOW  $T_f$  OR  $V_f$

\* DON'T KNOW BEHAVIOR OF STATE OF SYSTEM DURING PROCESS  $\rightarrow$  BUT FIRST LAW STILL HOLDS.

\* HOWEVER, NOW WE MUST USE EXTERNAL INFORMATION TO RELATE PROPERTIES AT INITIAL AND FINAL STATE

$$\text{1ST LAW: } \Delta u = \overset{Q=0}{\cancel{q}} - w$$

(STILL INSULATED)

$$C_v \Delta T = -w = -\underline{p_{\text{ext}} \Delta V}$$

$$1) C_v (T_f - T_i) = -p_{\text{ext}} (V_f - V_i)$$

AND IDEAL GAS LAW HOLDS AT INITIAL CONDITION AND FINAL CONDITION (BUT NOT IN BETWEEN)

$$2) p_f V_f = R T_f \quad \text{WHERE } p_f = p_{\text{ext}}$$

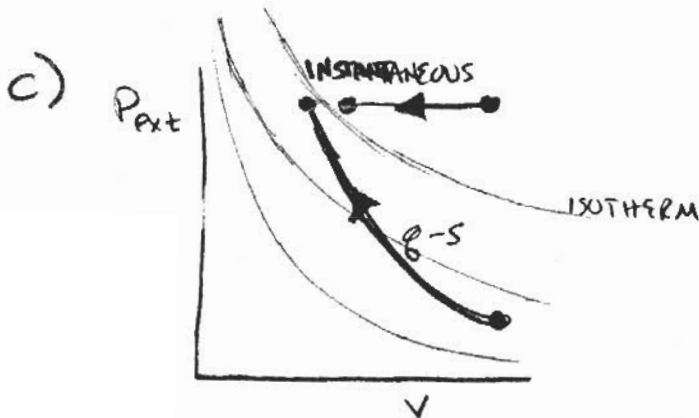
2 EQNS IN 2 UNKNOWNNS ( $T_f, V_f$ )

SUBSTITUTING,  $T_f = \frac{p_{\text{ext}} V_i + C_v T_i}{C_v + R} = \boxed{643.2 \text{ K}}$

ENDED UP AT A DIFFERENT STATE!

$$V_f = \frac{287 \cdot 643.2}{500,000} = \boxed{0.369 \text{ m}^3/\text{kg}}$$

$$W = -C_v \Delta T = -716.5 (643.2 - 300) = \boxed{-245.9 \text{ kJ/kg}}$$



LESS WORK REQUIRED TO COMPRESS THE GAS TO THE SAME PRESSURE VIA A Q-S PROCESS.  
∴ MORE EFFICIENT