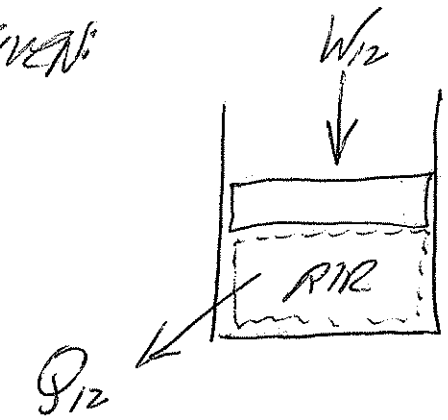
GIVEN:



DOUBLE CRS

$PV^n = CONST \rightarrow n = 1.25$

$m = .5\ lbm$

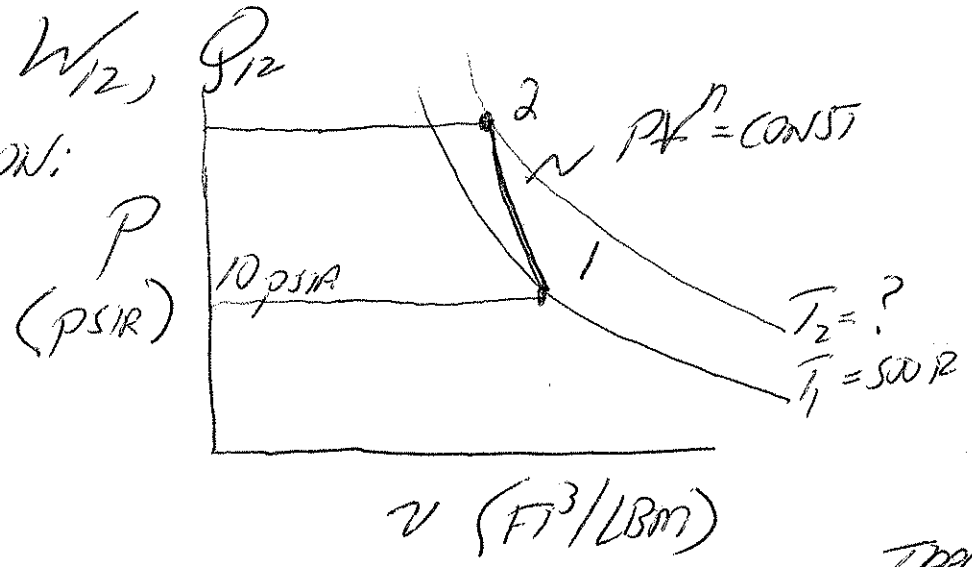
$T_1 = 500\ R$

$V_2 = 1\ FT^3$

$P_1 = 10\ psia$

FIND: W_{12}, Q_{12}

SOLUTION:



STATE 1

$P_1 = 10\ psia$

$T_1 = 500\ R$

$$v_1 = \frac{RT_1}{P_1} = \frac{\left(53.34 \frac{ft\text{-}lbf}{lbm\text{-}R}\right)(500\ R)}{\left(10 \frac{lbf}{in^2}\right)\left(144 \frac{in^2}{ft^2}\right)}$$

Table C.13a

$$v_1 = 18.52\ ft^3/lbm$$

$u_1 = 85.2\ BTU/lbm$

$h_1 = 119.48\ BTU/lbm$

} Table C.16a

STATE 2

$$v_2 = V_2/m = 18\,ft^3/.5\,lbm = 2\,ft^3/lbm$$

$$P_2 = P_1 (v_1/v_2)^n = 10\,psia \left(\frac{18.52\,ft^3/lbm}{2\,ft^3/lbm}\right)^{1.25}$$

$$P_2 = 161.53\,psia$$

$$T_2 = T_1 (v_2/v_1)^{1-n} = (500R)\left(\frac{2\,ft^3/lbm}{18.52\,ft^3/lbm}\right)^{1-1.25}$$

$$T_2 = 872\,R$$

$u_2 = 149.7\,BTU/LBM$ } INTERPOLATING FROM TABLE C.16a

$h_2 = 209.4\,BTU/LBM$ }

APPLYING 1ST LAW

$$Q_{12} - W_{12} = m(u_2 - u_1) + \Delta KE + \Delta PE$$

FOR POLYTROPIC PROCESS, $n \neq 1$

$$W_{12} = (P_2 V_2 - P_1 V_1)/1-n = \frac{mR(T_2 - T_1)}{1-n}$$

$$W_{12} = \frac{(.5\,lbm)\left(.0455\,\frac{BTU}{LBM\text{-}R}\right)(872.2 - 500)R}{1-1.25} = -51\,BTU$$

$$Q_{12} = m(u_2 - u_1) + W_{12}$$

$$Q_{12} = (.5\,lbm)(149.65 - 85.2)\frac{BTU}{lbm} + -51\,BTU$$

$$Q_{12} = \underline{\underline{-18.8\ BTU}}$$

Reflection:

Compression process → work done → -ve

Polytropes are steeper than isotherms!

RIT tables avoid messy integration of C_v, C_p!

$$\Delta u = \int_1^2 C_v(T)\,dT \qquad \Delta h = \int_1^2 C_p(T)\,dT$$