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Ch En Hw 3

1.) $T_1 = 300K$, $P_1 = 101$ kPa, $V_1 = 0.5\ m^3$ $\quad W = \int F dx = \int P dV$

$P_2 = 900$ kPa

$P = \frac{nRT}{V}$ $\therefore W = -\int_{V_1}^{V_2} \frac{nRT}{V} dV = -nRT[\ln V] = -nRT(\ln|V_2| - \ln|V_1|)$

$\cancel{nRT = PV \rightarrow W = PV \ln\left|\frac{V_2}{V_1}\right|}$ $\quad V_2 = \frac{nRT}{P_2}$, $V_1 = \frac{nRT}{P_1} \rightarrow V_2 P_2 = V_1 P_1$

$\therefore W = -P_1 V_1 \ln\left|\frac{P_1}{P_2}\right| \rightarrow \cancel{W = 101 kPa \cdot 0.5 m^3 \cdot \ln\left|\frac{101 kPa}{900 kPa}\right|}$ $\quad \frac{V_2}{V_1} = \frac{P_1}{P_2}$

$W = -nRT \ln\left|\frac{P_1}{P_2}\right|$ $\quad n = \frac{m}{M}$, $m = \rho \cdot V$

$M = 28.0134 \frac{g}{mol}$ $\quad m = 1.25 \frac{g}{L} \cdot 500 L$

$n = 22.32$ $\quad m = 625.3\ g$

$\therefore W = 22.32\ mol \cdot 8.314 \frac{m^3 Pa}{mol K} \cdot 300K \cdot \ln\left|\frac{101000}{900000}\right| Pa$

$= 121569.7\ J$ $\boxed{= 122\ kJ}$

b.) ~~Heat removed from the gas~~ $\quad \Delta U = Q - W$, $\Delta U = 0$ (isothermal)

$Q = W$

$\therefore Q = +122 \rightarrow \boxed{-122\ kJ}$ removed from gas

2.) $W = \int_a^b P dV \rightarrow W = P_x \int_a^b dV = P_x [V]_a^b = \underbrace{P_x [b-a] = W}$

$P_1 = 750$ kPa $\quad b = 0.02\ m^3$ $\quad P_{avg} = \frac{3550}{6} = 591.67$ kPa

$P_2 = 500$ $\quad$ ~~b = 0.01~~

$P_3 = 400$ $\quad a = 0.01\ m^3$ $\quad \therefore W = P_{avg}[0.02 - 0.01] m^3 \boxed{= 5.9\ kJ}$

$P_4 = 400$

$P_5 = 700$

$P_6 = 800$

Ch E_n HW3

3) $V_1 = 0.8\ m^3$ $\quad V_2 = 0.10\ m^3$, $\quad P = aV + b$

$a = -500\ kPa/m^3$ $\quad b = 500\ kPa$

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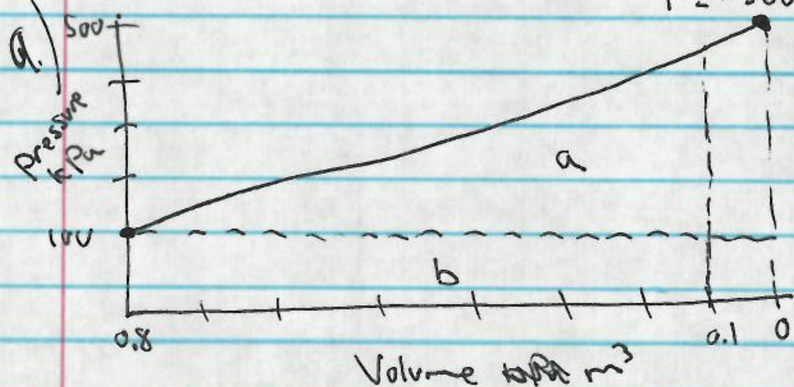
a.)



$P = -500V + 500$

$P(0.1) = -500 \cdot (0.10) + 500 = 450$

$A_a = \frac{1}{2} \cdot 0.7 \cdot 350 = 122.5\ m^2$

$A_b = 0.7 \cdot 100 = 70$

$\therefore A_{total} = A_a + A_b =$ ~~192.5~~

$A_{total} = 192.5\ m^2$

$\therefore \boxed{W = 192.5\ kJ}$

b) $W = -\int_{V_1}^{V_2} P\,dV$ $\qquad P = P_{avg} = 275\ kPa$

$\therefore W = -275[V_2 - V_1] = -275(-0.7) \boxed{= 192.5\ kJ}$

Compression of a Gas
Work=Area(a)+Area(b)
a
b
Pressure (kPa)
Volume (m^3)
500
400
300
200
100
0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1