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Chapter Two – Recommended problems
— A MINIMAL SET — (DO MORE!)

Problem 8

$n_1 = 1 \text{ mol}$ $n_2 = 1 \text{ mol}$

$T_1 = 300\text{ K}$ $T_2 = ?$

$P_1 = 10 \text{ atm}$ $P_2 = 1 \text{ atm}$

$C_V = 3/2 R$
monoatomic
(why monoatomic?)
⇒ Ideal

$V_1 = \frac{n_1 R T_1}{P_1}$ $V_2 = ?$

Solve for ΔE, q, w, ΔH

$w = - \int P dV$

Special condition (a) Isothermal, reversible

$T_2 = T_1 = 300K$ $P = \frac{nRT_1}{V}$

$$w = - \int_{V_1}^{V_2} \frac{nRT}{V} dV$$

But what's V_2? Easy ⇒ $V_2 = \frac{n_1 R T_1}{P_2}$ $T_2 = T_1$ Isothermal

$$w = -nRT \int_{V_1}^{V_2} \frac{dV}{V} = -nRT \ln \frac{V_2}{V_1} = -nRT \ln \frac{n_1 R T_1}{P_2 V_1}$$

$\Delta E = 0$ (constant T) $\therefore$ $q = -w$

$$\Delta H = \Delta E + \Delta (PV)$$

$$= 0 + (P_2 V_2 - P_1 V_1)$$

n_1RT_1/P_2 1 atm 10 atm $\frac{n_1RT_1}{P_1}$

$$= 0 +$$

$$= n_1 R T_1 V_2 - n_1 R T_1 V_1$$

Special condition (b) Expansion against a constant $P = 1 atm$ in a thermally isolated (adiabatic) syste

$P_2 = 1 atm$ $q = 0$ $V_2 = \frac{n_1 R T_2}{P_2}$?

$$w = -\int P\,dV = -P\int dV = -P_2(V_2 - V_1) = w$$

$$\Delta E = n\bar{C}_V(T_2 - T_1) = q + w = 0 + [-P_2(V_2 - V_1)]$$

$$n C_V(T_2 - T_1) = -P_2(V_2 - V_1)$$

T_2: unknown; T_1: Known; P_2: Known; V_2: Unknown; V_1: Known

But

$P_2 V_2 = n R T_2$

$$n C_V(T_2 - T_1) = -P_2\left(\frac{nRT_2}{P_2} - V_1\right)$$

?

Now can solve for T_2 Then know V_2

$\Delta H = n\bar{C}_P(T_2 - T_1)$ OR $\Delta H = \Delta E + \Delta(PV)$

$= n(C_V + nR)(T_2 - T_1)$ Should get same result.

$q = 0$

Special condition (c) in an adiabatic system

Expansion against a vacuum ($P_{ex} = 0$ atm)

$w = \int P dV = 0$ As $P \to 0$, $V \to \infty$

$\Delta E = q + w = 0 + 0 = 0$

$\therefore T_2 = T_1$ $\Delta H = C_p(T_2 - T_1) = 0$

($\cancel{\Delta E + \Delta(PV)}$) OOPS CAN'T READILY CALC. ($V \to \infty$)