

LR

Recitation Quiz 1-26-04

↑ (a). A mole of each of these solids has the same number of atoms. There should therefore be the same number of degrees of freedom, each being allowed $\frac{1}{2}RT$ of energy. Therefore, they will have about the same molar heat capacity.

(b) To determine whether the system does work on the surroundings, we need to know the sign of ΔV -- does it expand or contract.

$$W = -P\Delta V = -P(V_F - V_I)$$

$V_F - V_I > 0$ it does work for us

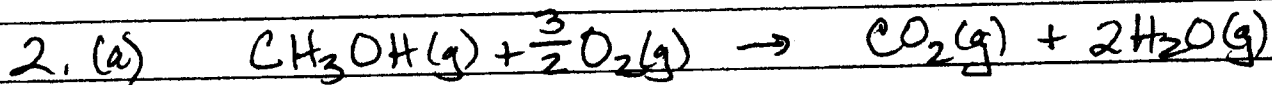
$V_F - V_I < 0$ we do work on it

Since $N_2 + O_2 \rightarrow 2NO$ is endothermic,

$$(\Delta H = \Delta H_f^\circ(NO) = 90 \text{ kJ/mol})$$

the temperature would have to decrease and hence the volume at constant pressure decreases. We will do work on the system to compress it.

Recitation quiz 1-26-04



(b) The pressure would be constant - the insulated room is like a coffee cup calorimeter.

We need $\Delta H = q_p$ to raise n moles of air ΔT

$$\Delta H = q_p = n C_p \Delta T \quad \text{We want } \Delta T = 5^\circ\text{C} = 5\text{K}$$

The number of moles of air is

$$n = \frac{PV}{RT} = \frac{1 \text{ atm} \times 10^5 \text{ liters}}{8.31 \text{ J/mole}\cdot\text{K} \times 298 \text{ K}} = 4063 \text{ moles}$$

$V = 4\text{m} \times 5\text{m} \times 5\text{m} = 100\text{m}^3 \times \left(\frac{100\text{cm}}{\text{m}}\right)^3 \times \frac{1 \text{ atm}}{101.325 \text{ kPa}} = 10^5 \text{ liters}$
 $p = 1 \text{ atm}$
 $T = 25^\circ\text{C} = 298 \text{ K}$
 $R = 8.31 \text{ J/mole}\cdot\text{K} \times \frac{1 \text{ atm}\cdot\text{m}^3}{101.325 \text{ J}}$

Note that $C_v = 21 \text{ J/mole}\cdot\text{K}$ but we need

$$C_p = C_v + R = 29.31 \text{ J/mole}\cdot\text{K}$$

$$\therefore \text{We need } \Delta H = (4063 \text{ moles}) (29.31 \text{ J/mole}\cdot\text{K}) (5\text{K}) = 5.95 \times 10^5 \text{ J}$$

Burning one mole of $\text{CH}_3\text{OH}(g)$ gives in kJ/mol

$$\Delta H = \Delta H_f(\text{CO}_2) + 2\Delta H_f(\text{H}_2\text{O}) - \cancel{\frac{3}{2}\Delta H_f(\text{O}_2)} - \Delta H_f(\text{CH}_3\text{OH})$$

$$\Delta H = -394 + 2(-242) - (-201) = -677 \text{ kJ/mol CH}_3\text{OH}$$

This much heat is released by the reaction per mole CH_3OH . and goes into heating the air

$$\# \text{ moles CH}_3\text{OH to burn} = \frac{5.95 \times 10^5 \text{ J}}{677 \text{ kJ}} \times \frac{1 \text{ kJ}}{1000 \text{ J}} = 0.879 \text{ moles}$$

$$\# \text{ gms CH}_3\text{OH} = 0.879 \text{ moles CH}_3\text{OH} \times 32 \text{ g/mole} = 28.1 \text{ g}$$