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Thermo Hw 7

1.) $Mg_{(s)} + H_2O_{\ell} \rightarrow Mg(OH)_{2\,(aq)} + H_{2(g)}$

$Mg_{(s)} + 2H_2O_{\ell} \rightarrow Mg(OH)_2 + H_{2(g)}$

$m_{mg} = 9.5\ g$

$m_w = 28.35\ g$

Need: $2\ H_2O$ for $1\ Mg$ $\therefore$ $n_{Mg} = \frac{m_{Mg}}{M_{Mg}} = 0.391\ mol$

$n_w = \frac{m_w}{M_w} = \frac{28.35\ g}{18.015\ g/mol} = 1.574\ mol$

$n_w > 2(n_{Mg})$ $\therefore$ We have enough water

1.) b) $H_f - H_i = 0$

$n_i^f = n_i + \nu_i \xi$ $\qquad H_{i(l)} = n\left(\Delta H^{\circ}_{T_R} + C_p \Delta T\right)$ ($\Delta T = T_i - T_R$)

$H_{i,w} = \left(\frac{600\ g}{18\ g/mol} + 1.574\right)\left(-285.8 + 0.0753\,(293.15 - 298.15)\right)$

$H_{i,w} = -9981.63\ (kJ)$

$H_{i,Mg} = 0.391\left(0 + 0.0249\,(293.15 - 298.15)\right) = -0.049\ kJ$

$H_{i,Mg(OH)_2} = 0$

$H_{i,H_2} = 0$

$H_{f,w} = -9622.11\ kJ$

$H_{f,Mg} = 0$

$H_{f,Mg(OH)_2} = -360.106\ kJ$

$H_{f,H_2} = 0.5391\ kJ$

$H_{i,tot} = -9981.7$

$H_{f,tot} = -9981.68$

When $\Delta H = 0$, $T = 72.89\ ^{\circ}C$

Solved in Excel

2. $T_1 = 298.15\,K$, $T_2 = 1250\,K$

$$\underset{-1}{CO} + \underset{-1}{H_2O} \longrightarrow \underset{1}{CO_2} + \underset{1}{H_2}$$

$$\Delta H_T = \Delta H_R + \Delta a\left(T - T_R\right) + \frac{\Delta b}{2}\left(T^2 - T_R^2\right) + \frac{\Delta c}{3}\left(T^3 - T_R^3\right) + \frac{\Delta d}{4}\left(T^4 - T_R^4\right)$$

$\Delta H_R = \Sigma v_i \Delta H_{f_i}$ $\qquad$ $\Delta a = \Sigma v_i a_i$

@ $298.15\,K$: $T = T_R$ $\therefore$ $\Delta H_T = \Delta H_R + 0 \rightarrow \Delta H_T = \Sigma v_i H_{f_i}$ (Solved in excel)

$\therefore$ $\boxed{\Delta H_T = -41.145\ \frac{kJ}{mol}}$

@ $1250\,K$: $\Delta a = 0.031(-1) + 0.32(-1) + 0.0198(1) + 0.027(1)$

$\Delta a = -1.62 \times 10^{-2}$

Repeat with values of b, c, d (Solved in excel)

$\Delta a = -1.62 \times 10^{-2}$
$\Delta b = 9.36 \times 10^{-5}$
$\Delta c = -1.08 \times 10^{-7}$
$\Delta d = 4.11 \times 10^{-11}$

$\therefore$ $\Delta H_T = -41.145 + \Delta a\left(1250 - 298.15\right) + \frac{\Delta b}{2}\left(1250^2 - 298.15^2\right) + \frac{\Delta c}{3}\left(1250^3 - 298.15^3\right) + \ldots$

Solved in excel: $\boxed{\Delta H_T = -32.1\ \frac{kJ}{mol}}$

3.) Closed, Steady, Reversible : $\frac{dS}{dt} = \sum \frac{\dot{Q}}{T} + \dot{S}_{gen}$

$\frac{dS}{dt} = 0$; $\dot{S}_{gen} = 0$

$$0 = \sum \frac{\dot{Q}}{T} = \frac{1200\ kw}{1000\ K} - \frac{300\ kw}{450\ K} - \frac{500\ kw}{X\ K}$$

$$\frac{500}{x} = \frac{12}{10} - \frac{30}{45} \rightarrow \frac{500}{x} = 0.533 \rightarrow x = \frac{500}{0.533} = 938\ K$$