a) The differential form of the Gibbs energy is:

$$dG = VdP - SdT$$

This differential can be used to determine both the pressure and temperature dependence of the free energy.

G – Gibbs free energy, dG - differential form of the Gibbs free energy, S – entropy, V – volume, T – temperature, P – pressure.

b) $\Delta G = \Delta H - T\Delta S = -286000 J/mol - 373.15 K * 70 J/mol \cdot K = -312120.5 J/mol$

$\Delta G < 0$, the process will proceed spontaneously.

c) $d\ln K_{eq} = -\dfrac{\Delta H^0}{R} d(1/T)$

$\ln(\dfrac{K_2}{K_1}) = -\dfrac{\Delta H^0}{R} (\dfrac{1}{T_2} - \dfrac{1}{T_1})$

From this form of the van't Hoffs equation, we see that at constant pressure, a plot with $\ln K_{eq}$ on the y-axis and $1/T$ on the x-axis has a slope given by $-\Delta H/R$. For an endothermic reaction, the slope is negative, for an exothermic reaction, the slope is positive.

d) $\ln(K_2) - \ln(K_1) = \dfrac{\Delta H^0}{R} (\dfrac{1}{T_1} - \dfrac{1}{T_2})$

$\ln(0.010898) - \ln(0.1678) = \dfrac{\Delta H^0}{R} (\dfrac{1}{1274} - \dfrac{1}{1073})$

$-4.52 + 1.78 = \dfrac{\Delta H^0}{R} (0.000785 - 0.000932)$

$-2.74 = \dfrac{\Delta H^0}{R} (-0.000147)$

$\dfrac{\Delta H^0}{R} = 18639.5$ kJ/mol - the standard molar enthalpy change