SOLUTIONS

1. $-w = P_{Ext.}\Delta V = 1\times 0.5\,\text{Latm} \approx 50.65\,\text{J} \Rightarrow w = -50.65\,\text{J}$

2. $-w = P\Delta V = P(V_g - V_\ell) \approx PV_g = nRT = 1\times 8.314\times 373 \Rightarrow w = -3.10\,\text{kJ}$

3. $800 = \Delta U + 1\times(14-4)\times 101.3 \Rightarrow \Delta U = 800 - 1013 = -213\,\text{J}$

4. $Zn + HCl \longrightarrow H_2 + ZnCl_2$

$\Delta_r G = \Delta_r H - T\Delta_r S = -12.55 - 290\times 5\times 10^{-3} = -14\,\text{kJmol}^{-1}$

$\Delta_r G < 0$ (spontaneous)

5. $\Delta G = 40.64 - T\times 108.8\times 10^{-3} \Rightarrow T = 373.53\,\text{K}$

At $T > 373.5$ K ; reaction will become sponteneous.

6. Refer to theory

7.(D) $\Delta_r G = \Delta_r H - T\Delta_r S$; $\Delta_r H < 0$ and $\Delta_r S < 0 \Rightarrow$ Reaction is spontaneous at low T and non-spontaneous at high T

8.(B) If an ideal gas expands in vaccum, $\Delta S > 0$; T = const., $\Delta U = 0$; P↓

9.(D) $\Delta_r G = \Delta_r H - T\Delta_r S \Rightarrow T = \dfrac{20}{50}\times 1000 = 400\,\text{K}$

$\Rightarrow$ Above 400 K, reaction is non-spontaneous.

10.(A) $\left.\begin{aligned}\Delta_r G^\ominus = 50 = \Delta_r H^\ominus - 250\Delta_r S^\ominus\\ \text{and}\quad 30 = \Delta_r H^\ominus - 350\Delta_r S^\ominus\end{aligned}\right\} \Rightarrow \Delta_r S^\ominus = 200\,\text{J/K}$

11.(C) $q = \Delta U + (-w) = -52\,\text{kJ} + 1.5\,(30)\,\text{Latm} = -57\text{kJ} + 4.559\text{kJ} = -47.4\text{kJ}$

12.(A) $H_2O(\ell) \rightleftharpoons H_2O(g)$; Reversible process at equilibrium : $\Delta G = 0$; $\Delta S > 0$

13.(CD) Check for increase in the number of gaseous moles.

14.(C) $\Delta_r G$ always be negative, if $\Delta_r H < 0$ and $\Delta_r S > 0$

15.(C) $\Delta_r S = \dfrac{2090}{(290)} = 7.2\,\text{J K}^{-1}\text{mol}^{-1}$

16.(B) $\Delta_r S^\ominus = 2(27.3) + 3(69.9) - (87.3) - 3\times 130.7 = -215.1\,\text{Jmol}^{-1}\text{K}^{-1}$

17.(A) $\Delta_r S^\ominus$ has to be zero. For this change in number of moles should be zero.

18.(A) Use : $\ell n\dfrac{P_2}{P_1} = \dfrac{\Delta_r H}{R}\left(\dfrac{1}{T_1} - \dfrac{1}{T_2}\right) \Rightarrow \ell n\dfrac{0.35}{0.14} = \dfrac{\Delta_r H}{8.314}\left(\dfrac{1}{400} - \dfrac{1}{420}\right) \Rightarrow \Delta_r H = 64.08\,\text{kJmol}^{-1}$

19.(D) $\Delta S_{A\to B} = \Delta S_{A\to C} + \Delta S_{C\to D} + \Delta S_{D\to B} = 50 + 30 - 20 = 60$

20.B) $-54.07 - 298\times 10\times 10^{-3} = -2.303\,RT\log_{10} K_{eq} \Rightarrow \log_{10} K_{eq} = 10$

21.(B) $\Delta G = \Delta H - T\Delta S$

$\Delta G = 177 \times 10^3 - 298 \times 285 = 177000 - 84930 = 92070\ J = 92.07\ kJ.$

Since the sign of ΔG is positive, it is non spontaneous reaction.

22.(B) $\Delta H > 0$ and ΔS must be positive as the reaction becomes spontaneous from non-spontaneous on increasing temperature.

23.(B) $\Delta G = -2.303\ RT \log K_{eq}$

$= -2.303 \times 8.314 \times 298 \times \log (10^{-14})$

$= 2.303 \times 8.314 \times 298 \times 14 \approx 8 \times 10^4\ J$

24.(A) If $\Delta H < 0$ and $\Delta S < 0$ (decrease in number of moles of gas) then reaction will be spontaneous at low temperature and non-spontaneous at high temperature because $\Delta G > 0$ at high temperature.

25.(B) C_6H_6 is in liquid state.

$\Delta H < 0$ for combustion reactions.

$\Delta S > 0$ more gaseous substances

$\Delta G < 0$ spontaneous reaction

26.(D) When $\Delta H > 0$, and $\Delta S < 0$ then $\Delta G > 0$ at all temperature hence reaction will be non-spontaneous and impossible to occur.

27.(C) From $\Delta G = \Delta H - T\ .\ \Delta S$

For an ideal gas at isothermal condition, $\Delta T = 0$ and $\Delta H = 0$

$\Rightarrow \quad \Delta G = T - \Delta S$?

28.(C) Most easily decomposed metal oxide will be HgO becasue value of $\Delta G°$ for formation of oxide will becomes less negative at higher temperature.