JEE previous year questions:

Chemical Thermodynamics-IV

1. For water $\Delta_{vap} H = 41$ kJ mol^{--1} at 373 K and 1 bar pressure. Assuming that water vapour is an ideal gas that occupies a much larger volume than liquid water, the internal energy change during evaporation of water is ___________ kJ mol^{-1} [Use: R = 8.3 J mol^{-1} K^{-1}] (JEE Mains, 2021)

   Ans: 38

   Explanation:

   $H_2O(l) \rightarrow H_2O(g)$

   $\Delta H = 41$ kJ/mol (given)

   We know, $\Delta H = \Delta U + \Delta n_g RT = 41 kJ/mol = \Delta U + 1 \times (8.3/1000) \times 373$

   (As, R = (8.3/1000) kJ mol^{-1} K^{-1})

   $\Delta U = 41 - 3.0959 = 38$ kJ/mol

2. For water at 100˚C and 1 bar, $\Delta_{vap} H - \Delta_{vap} U =$ _____________ $\times 10^2$ J mol^{-1}. (Round off to the Nearest Integer)

   [Use: R = 8.31 J mol^{-1} K^{-1}]

   [Assume volume of $H_2O(l)$ is much smaller than volume of $H_2O(g)$. Assume $H_2O(g)$ treated as an ideal gas] (JEE Mains, 2021)

   Ans:31

   Explanation:

   $H_2O(l) \rightarrow H_2O(g)$

   $\Delta_{vap} H - \Delta_{vap} U = \Delta n_g RT = 1 \times 8.31 \times 373 \approx 31 \times 10^2$ J

3. The difference between ΔH and ΔU ($\Delta H - \Delta U$), when the combustion of one mole of heptane(l) is carried out at a temperature T, is equal to: (JEE Mains, 2019)

   A) -4RT
   B) 3RT
   C) -3RT
   D) 4RT

   Ans: A) -4RT

   Explanation:

$\Delta H - \Delta U = \Delta n_g RT$

$C_7H_{16}(l) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(l)$

Here, $\Delta n_g = 7 - 11 = -4$

$\therefore \Delta H - \Delta U = -4RT$

4. For silver, $C_p(J\ K^{-1}\ mol^{-1}) = 23 + 0.01\ T$. If the temperature (T) of 3 moles of silver is raised from 300 K to 1000 K at 1 atm pressure, the value of ΔH will be close to :
   A) 62 kJ
   B) 16 kJ
   C) 13 kJ
   D) 21 kJ (JEE Mains, 2019)

   Ans: A) 62 kJ

$n = 3$

$T_1 = 300$

$T_2 = 1000$

$C_p = 23 + 0.01T$

We know,

$\Delta H = \int_{T1}^{T2} nCpdT$

$= \int_{300}^{1000} 3(23 + T100)dT$

$= 3[23T + T^2/200]$

$= 3[\ 23(1000 - 300) + (1/200)\ \{(1000)^2 - (300)^2\}]$

$= 61950$ J

$= 61.95$ kJ

$\simeq 62$ kJ