[JEE (Main)-2015]

263a. The following reaction is performed at 298 K.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

The standard free energy of formation of NO(g) is 86.6 kJ/mol at 298 K. What is the standard free energy of formation of $NO_2(g)$ at 298 K?

($K_p = 1.6 \times 10^{12}$)

(1) $R(298)\ln(1.6 \times 10^{12}) - 86600$

(2) $86600 + R(298)\ln(1.6 \times 10^{12})$

(3) $86600 - \dfrac{\ln\left(1.6\times10^{12}\right)}{R(298)}$

(4) $0.5\left[2\times86,600 - R(298)\ln 1.6\times10^{12}\right]$

Sol. $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

We are given K_p.

So, $\Delta G^\circ_r = -RT \ln K_p$.

Also, $\Delta G^\circ_r = 2 \cdot \Delta G^\circ_{NO_2} - 2\Delta G^\circ_{NO}$

$(\because \Delta G^\circ_{O_2} = 0)$

So, $-RT \ln K_p = 2\Delta G^\circ_{NO_2} - 2 \times 86600$

$\therefore 2\Delta G^\circ_{NO_2} = 2 \times 86600 - R \times 298 \ln(K_p)$

$\therefore \Delta G^\circ_{NO_2} = 0.5\left\{2 \times 86600 - R \times 298 \times \ln(1.6 \times 10^{12})\right\}$.