5. 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? ($KP = 1.6 \times 10^{12}$)

(1) R(298) in ($1.6 \text{ X } 10^{12}$) – 86600 (2) 86600 + R(298) ln ($1.6 \text{ X } 10^{12}$)

(3) 86600 - $\frac{ln(1.6 \times 10^{12})}{R(298)}$ (4) 0.5 [2 X 86,600 – R (298) ln($1.6 \text{ X } 10^{12}$)]

Answer: We know that Standard Free Energy of reaction

$(\Delta G^0) = (\Delta G^0)_{Product} - (\Delta G^0)_{Reactant}$

$-RTlnK_p = 2(\Delta G^0)_{NO_2} - 2(\Delta G^0)_{NO}$ [Assumed $(\Delta G^0)_{O_2} = 0$]

$2(\Delta G^0)_{NO_2} = 2(\Delta G^0)_{NO} - RTlnK_p$

$2(\Delta G^0)_{NO_2} = 2 \times 86600 - R \times 298 \times ln1.6 \times 10^{12}$

$(\Delta G^0)_{NO_2} = 0.5[2 \times 86600 - R \times 298 \times ln1.6 \times 10^{12}]$

Correct option is (4) 0.5 [2 X 86,600 – R (298) ln($1.6 \text{ X } 10^{12}$)]