Chemical Equilibrium

Question1

Identify the reaction intermediate of following reaction.

i. $2SO_{2(g)} + 2NO_{2(g)} \rightarrow 2SO_{3(g)} + 2NO$

ii. $2NO_{(g)} + O_{2(g)} \rightarrow 2NO_{2(g)}$

$2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

MHT CET 2023 12th May Evening Shift

Options:

A. $NO_{2(g)}$

B. $NO_{(g)}$

C. $SO_{2(g)}$

D. $O_{2(g)}$

Answer: B

Solution:

Intermediate should not be present in overall reaction. $NO_{(g)}$ is the only species in the above reaction mechanism that is absent in overall reaction and hence, it is an intermediate.

Question2

Weak acid HX has dissociation constant 1×10^{-5}. Calculate the percent dissociation in its $0.1M$ solution.

MHT CET 2023 10th May Evening Shift

Options:

A. 2.2%

B. 3.5%

C. 4.2%

D. 1.0%

Answer: D

Solution:

$$\mathrm{K_a} = 1 \times 10^{-5}, \mathrm{c} = 0.1\mathrm{M}$$
$$\mathrm{K_a} = \alpha^2 \mathrm{c}$$
$$\therefore \quad \alpha = \sqrt{\frac{\mathrm{K_a}}{\mathrm{c}}} = \sqrt{\frac{1 \times 10^{-5}}{0.1}} = \sqrt{1 \times 10^{-4}} = 0.01$$

$$\alpha = \frac{\text{Percent dissociation}}{100}$$
$$\begin{aligned}\text{Percent dissociation} &= \alpha \times 100 \\ &= 0.01 \times 100 = 1.0\%\end{aligned}$$

Question3

What is molar concentration of weak monobasic acid if dissociation constant is 5×10^{-8} and undergoes 0.5% dissociation?

MHT CET 2021 20th September Evening Shift

Options:

A. 0.03 M

B. 0.002 M

C. 0.001 M

D. 0.005 M

Answer: B

Solution:

$$K_a = 5 \times 10^{-8}, \alpha = 0.5\% = \frac{0.5}{100} = 5 \times 10^{-3}$$

$$K_a = \alpha^2 c$$

$$\therefore \mathrm{c} = \frac{K_a}{\alpha^2} = \frac{5 \times 10^{-8}}{\left(5 \times 10^{-3}\right)^2} = \frac{5 \times 10^{-8}}{25 \times 10^{-6}}$$

$$= 0.002\mathrm{M}$$

Question4

Equilibrium constant for a reaction is 20. What is the value of ΔG° at 300 K? $\left(R = 8 \times 10^{-3}\ \mathrm{kJ}\right)$

MHT CET 2020 16th October Evening Shift

Options:

A. $-7.191\ \mathrm{kJ\ mol^{-1}}$

B. $-5.527\ \mathrm{kJ\ mol^{-1}}$

C. $-2.763\ \mathrm{kJ\ mol^{-1}}$

D. $-1.663\ \mathrm{kJ\ mol^{-1}}$

Answer: A

Solution:

Given:

Equilibrium constant, $K_{\mathrm{eq}} = 20$

Temperature, $T = 300\,\mathrm{K}$

Gas constant, $R = 8 \times 10^{-3}\,\mathrm{kJ \cdot mol^{-1} \cdot K^{-1}}$

To find the standard Gibbs free energy change (ΔG°), use the following equation:

$$\Delta G^\circ = -2.303 \times R \times T \times \log K_{\text{eq}}$$

Substituting the given values:

$$\begin{aligned}\Delta G^\circ &= -2.303 \times 8 \times 10^{-3} \times 300 \times \log 20 \\ &\quad (\text{given } \log 20 = 1.301) \\ &= -2.303 \times 8 \times 10^{-3} \times 300 \times 1.301 \\ &= -7.191\,\mathrm{kJ \cdot mol^{-1}}\end{aligned}$$
