Quiz 15.2 – Working With K and Q

Name: Key

For questions 1–3, consider the reaction: $H(g) + Br(g) \rightleftharpoons HBr(g)$ ★

Question 1

Calculate K from the following reactions:

Ⓐ $H_2(g) \rightleftharpoons 2\,H(g) \quad K = 11.8$

Ⓑ $Br_2(g) \rightleftharpoons 2\,Br(g) \quad K = 1.15 \times 10^{-5}$

Ⓒ $Br_2(g) + H_2(g) \rightleftharpoons 2\,HBr(g) \quad K = 2.78 \times 10^{3}$

★ $= -\frac{1}{2}$Ⓐ $- \frac{1}{2}$Ⓑ $+ \frac{1}{2}$Ⓒ

So $K_{★} = \dfrac{\sqrt{K_{Ⓒ}}}{\sqrt{K_{Ⓐ} K_{Ⓑ}}} = 4,530$

Question 2

If the system has reached equilibrium with $[HBr] = 0.025\ M$ and $[H] = 0.0015\ M$, find $[Br]$

$4,530 = \dfrac{[HBr]}{[H][Br]} \qquad 4530 = \dfrac{0.025\,M}{0.0015\,M \cdot [Br]} \rightarrow [Br] = 0.0037\,M$

Question 3

Find the reaction quotient Q and predict which direction the reaction must shift to reach equilibrium if $[HBr] = 0.0035\ M$, $[H] = 0.020\ M$, and $[Br] = 0.0025\ M$

$Q = \dfrac{[HBr]}{[H][Br]} = \dfrac{0.0035\,M}{0.020\,M \cdot 0.0025\,M} = 70$

$Q < K$, so the reaction must shift toward products

Question 4

The reaction $H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g)$ is at equilibrium with $[H_2] = 0.05\ M$, $[I_2] = 0.05\ M$, and $[HI] = 0.90\ M$. Calculate K from these values

$K = \dfrac{[HI]^2}{[H_2][I_2]} = \dfrac{0.90^2}{0.05 \cdot 0.05} = 324$

Bonus Question!

Comparing the K values for the production of HBr and HI from their elemental constitutents, what can you say about the relative stability of HBr and HI?

Compare 324 to 2,780 (from equation Ⓒ) for HBr. HI is less stable than HBr