Worksheet 6.2

# Equilibrium constant calculations

**NAME:** **CLASS:**

## INTRODUCTION

A variety of question types involving the calculation of equilibrium constants or equilibrium concentrations are presented in this worksheet. Much of this worksheet is an extension of the concepts specified in the Level 3 course content.

| No | Question | Answer |
|---|---|---|
| **1** | Write equilibrium constant expressions for each of the following equations:<br>**a** $N_2(g) + 3F_2(g) \rightleftharpoons 2NF_3(g)$<br>**b** $SnCl_2(aq) + 2HNO_3(aq) \rightleftharpoons Sn(NO_3)_2(aq) + 2HCl(aq)$<br>**c** $2VO_3^-(aq) + 6H^+(aq) + SO_3^{2-}(aq) \rightleftharpoons 2VO^{2+}(aq) + 3H_2O(l) + SO_4^{2-}(aq)$<br>**d** $2H_2S(g) + 3O_2(g) \rightleftharpoons 2SO_2(g) + 2H_2O(g)$ | |
| **2** | For each of the following equilibrium systems, state whether the reactants or products would be present in the larger amount:<br>**a** $Ca^{2+}(aq) + C_2O_4^{2-}(aq) \rightleftharpoons CaC_2O_4(s)$<br>$K = 3.8 \times 10^{-9}$ at 25°C<br>**b** $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$<br>$K = 3.8 \times 10^5$ at 475°C<br>**c** $H_2(g) + F_2(g) \rightleftharpoons 2HF(g)$<br>$K = 145$ at 40°C | |

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| **3** | Dinitrogen tetrafluoride decomposes to nitrogen difluoride according to the following equation:<br>$N_2F_4(g) \rightleftharpoons 2NF_2(g)$<br>$K = 9.24 \times 10^{-3}$ at 10°C<br>Calculate the value of $K$, at 10°C, for the equations shown:<br>**a** $2NF_2(g) \rightleftharpoons N_2F_4(g)$<br>**b** $2N_2F_4(g) \rightleftharpoons 4NF_2(g)$ | |
| **4** | Determine the magnitude of the equilibrium constant for the reaction:<br>$2NO_2(g) + 7H_2(g) \rightleftharpoons 2NH_3(g) + 4H_2O(l)$<br>given $[NO_2] = 0.056$ mol $L^{-1}$, $[H_2] = 0.335$ mol $L^{-1}$ and $[NH_3] = 1.52$ mol $L^{-1}$. | |
| **5** | Calculate the concentration of NO(g) at equilibrium for the reaction:<br>$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$<br>$K = 1.60 \times 10^{-5}$ at 35°C<br>given $[NOCl] = 0.746$ mol $L^{-1}$ and $[Cl_2] = 1.89 \times 10^{-3}$ mol $L^{-1}$. | |
| **6** | Barium sulfate is used to generate X-rays of the digestive tract, as it is opaque to<br>X-rays. It dissolves to only a small extent in water according to the equation:<br>$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$<br>$K = 1 \times 10^{-10}$ at 25°C<br>Given that $[BaSO_4] = 1$ (by definition, as it is a solid), determine the equilibrium concentrations of $Ba^{2+}$ and $SO_4^{2-}$ in the solution. | |

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| **7** | Consider the reaction<br>$A(g) + 2B(g) \rightleftharpoons C(g)$ $K = 0.0812$<br>Calculate the concentration of species B, given that [A] = 0.722 mol $L^{-1}$ and [C] = 0.0394 mol $L^{-1}$ at equilibrium. | |
| **8** | 0.600 mol of $N_2O_4(g)$ is introduced into an evacuated 2.00 L vessel and allowed to reach equilibrium according to the equation:<br>$N_2O_4(g) \rightleftharpoons 2NO_2(g)$<br>At equilibrium, 0.140 mol of $N_2O_4$ remains. Calculate the equilibrium constant for the reaction at this temperature. | |
| **9** | 1.85 mol of $PCl_5$ was introduced into an evacuated 2.00 L vessel. Once equilibrium was established, 20% of the $PCl_5$ remained. Calculate the equilibrium constant for the equation:<br>$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ | |
| **10** | A 2.30 mol sample of nitrosyl bromide, NOBr, is introduced into a 6.50 L vessel. At equilibrium, the concentration of nitrosyl bromide is 0.0774 mol $L^{-1}$. Calculate the equilibrium constant for the following reaction:<br>$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$ | |