Exercise 4.1.

For following oxides, write down the defect formation processes (Schottky, Anti-Schottky, Frenkel, Antti-Frenkel) and suitable reaction constant for each:

- Cu_2O
- Cr_2O_3
- TiO_2
- V_2O_5

Exercise 4.2.

For Cu_2O, knowing that the main type of defects are Frenkel defects and knowing values of K_S, K'_S, K'_F, find concentration of interstitial copper ions.

Exercise 4.3.

Find all defect concentrations ($[V_{Ti}^{4\prime}]$, $[V_O^{\bullet\bullet}]$, $\left[Ti_i^{4\bullet}\right]$, $[O_i^{\prime\prime}]$) for TiO_2. Assume that dominating type of defects are Schottky defects. K_F, K'_S, K'_F are known.

Exercise 4.4.

For given oxides, write defect formation processes (and reaction constants) assuming nonstochiometry of compounds. For every oxide take under consideration all possible cases:

- Excess of a metal ($Me_{n+y}X_m$)
- Shortage of an oxidant (Me_nX_{m-y})
- Shortage of a metal ($Me_{n-y}X_m$)
- Excess of an oxidant (Me_nX_{m+y})

Oxides:

- Cr_2O_3
- ZrO_2
- Cu_2O

Exercise 4.5.

Knowing that ZnO usually has an excess of a metal, $Zn_{1+y}O$, find concentrations of every type of defects ($[V_O^{\bullet\bullet}]$, $[e^-]$, $\left[Zn_i^{2\bullet}\right]$, $[h^\bullet]$, $[O_O^{\prime\prime}]$, $[V_{Zn}^{2\prime}]$) as a functions of oxygen pressure. All reaction constantans (K_1, K_2, K_3, K_4, K_F, K_F', K_S, K_S', K_e) are known, where:

$$K_e = [h^\bullet][e^-]$$

Exercise 4.6.

Knowing that ZrO_2 usually has shortage of oxygen: ZrO_{2-y} , find concentrations of every type of defects ($[V_O^{\bullet\bullet}]$, $[e^-]$, $\left[Zr_i^{4\bullet}\right]$, $[h^\bullet]$, $[O_O'']$, $[V_{Zr}^{4\prime}]$) as a functions of oxygen pressure. All reaction constantans (K_1, K_2, K_3, K_4, K_F, K_F', K_S, K_S', K_e) are known, where:

$$K_e = [h^\bullet][e^-]$$