***Exercises 12      13.05.2025***

**1**.(a) At temperature T=1350 K an oxide $M_2O$ contains the following defects: Frenkel anionic with energy of formation Δh=7.5 eV, Frenkel cationic with energy of formation Δh=6.5 eV, Schottky defects with energy of formation Δh=3 eV. Which type of intrinsic ionic defects is predominant? (Boltzmann constant = $1.38 \times 10^{-23}$ J/K = $8.62 \times 10^{-5}$ eV/K)

(b) Write equations of formation of dominant defects under conditions of oxygen excess and oxygen deficiency. From the equilibrium constants determine how the defect concentrations depend on the oxygen partial pressure (use the approach that we used for constructing Brouwer diagram in the Lecture) *Indication:* unlike previous examples, for some defects you should obtain the dependence of $p^{1/8}$ .

**2.** Component of the tensor of elastic constants $c_{44}$ of a crystal is measured by deforming a plate with tangential forces applied as shown in figure. These forces generate the stress component $\sigma_4$ , the resulting shear deformation is calculated (the other stress components are zero) . The sought tensor component is calculated as $c_{44} = \sigma_4 / \varepsilon_4$. The faces of the plate parallel to X2-X3 planes are covered with thin electrodes. The measurements are performed two times: (i) at disconnected electrodes and (ii) at short-circuited electrodes.

Will there be any difference in the obtained values of $c_{44}$ in these experiments? If yes, calculate this difference in terms of components of material tensors of the crystal (e.g. $K_{ij}, d_{in}, s_{nm}, c_{nm}$).

The symmetry of the crystal is $\bar{4}3m$. The crystallographic reference frame (X1, X2, X3) is shown on figure.