Self-assessment test with focus on COSOM subjects (1)

1. At given temperature T_1 a real gas has a certain volume V_1 and a certain pressure p_1. Upon isothermal compression the gas will start to liquefy until it is fully liquid at a volume of $0.2\ V_1$. Calculate the mole fraction of the substance at a volume of $0.3\ V_1$ in liquid phase and gas phase respectively.

2. The combustion enthalpy of ethanol (C_2H_5OH) is -1368 kJ/mol. During the combustion of ethanol under constant pressure in a calorimeter with a heat capacity of 7.3 kJ/K, an increase in temperature of T = 1500 K is measured. Calculate the mass of ethanol burned in this process. Notes: molar masses of C: 12.01 g/mol, H: 1.01 g/mol and O: 16.00 g/mol

3. Condensed phases are the consequence of intermolecular forces.
   a) What is the intermolecular force that allows us to liquefy noble gases?
   b) Which are the major quantities?
   c) How does the interaction potential V(R) depend on the distance R between the nuclei?

4. Consider a system consisting of one component. Upon increase of temperature at constant pressure, the system undergoes a phase transition from liquid to gaseous. Sketch the heat capacity (c_V) curve as a function of temperature (T). How does the magnitude change during phase transition and what value does c_V then take on?

5. Sketch the (p, T) phase diagram of water.
   a) Mark all the present phases. What is the so-called “anomaly of water”?
   b) Can a phase diagram of a pure substance show more than one triple point? If so, please give an example.

6. How does the equilibrium constant k depend on the temperature? How can one measure this dependency?