浙江大学 2010－2011 学年 秋冬 学期

《物理化学》课程期末考试试卷

诚信考试，沉着应考，杜绝违纪。

题　序	一	二	三	四	五	六	七	总分
得　分								
评卷人								

1. A perfect gas consisting of 1.0 mol H_2 is expanded isothermally at 298 K from 200 kPa to 100 kPa against a constant external pressure equal to the final pressure of the gas.

(a) Calculate q, w, ΔU, ΔH, ΔG, and ΔA.

(b) Calculate the change in entropy of the system.

(c) Calculate the entropy change of the surroundings.

(d) Is this process spontaneous? Why? (15 scores)

2. 1 mol of liquid water at $100\,°C$ and 100 kPa is changed into water vapor at $100\,°C$ and 100 kPa under the following conditions. Calculate the entropy change of the system and the entropy change of the surroundings (Assume that the volume of liquid water can be neglected and water vapor can be considered as a perfect gas. At $100\,°C$ and 100 kPa, $\Delta_{vap}H = 40.66$ $kJ \cdot mol^{-1}$).

(a) Vaporizing reversibly in the air;

(b) Vaporizing in a vacuum container.   (15 scores).

3. A container is divided into the following two equal compartments. One contains 3.0 mol H_2 at 298 K, and the other contains 1.0 mol N_2 at 298 K. Calculate the change in Gibbs energy of mixing when the partition is removed. Assume perfect behavior. (15 scores).

| 3.0 mol H_2 3P	1.0 mol N_2 P

↓

3.0 mol H_2 1.0 mol N_2

4. Observe the following solid-liquid phase diagram.

(a) State what substances exist in each region.

(b) Sketch the cooling curves for the given systems a and b.

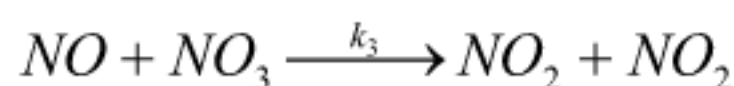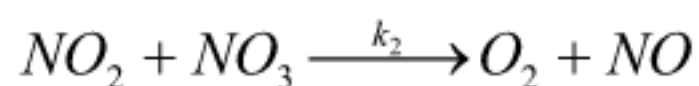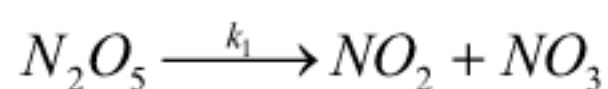(c) What is the composition of the eutectic mixture and at what temperature does it melt?

(d) What are the features (composition and temperature) that denote incongruent melting?   (15 scores)
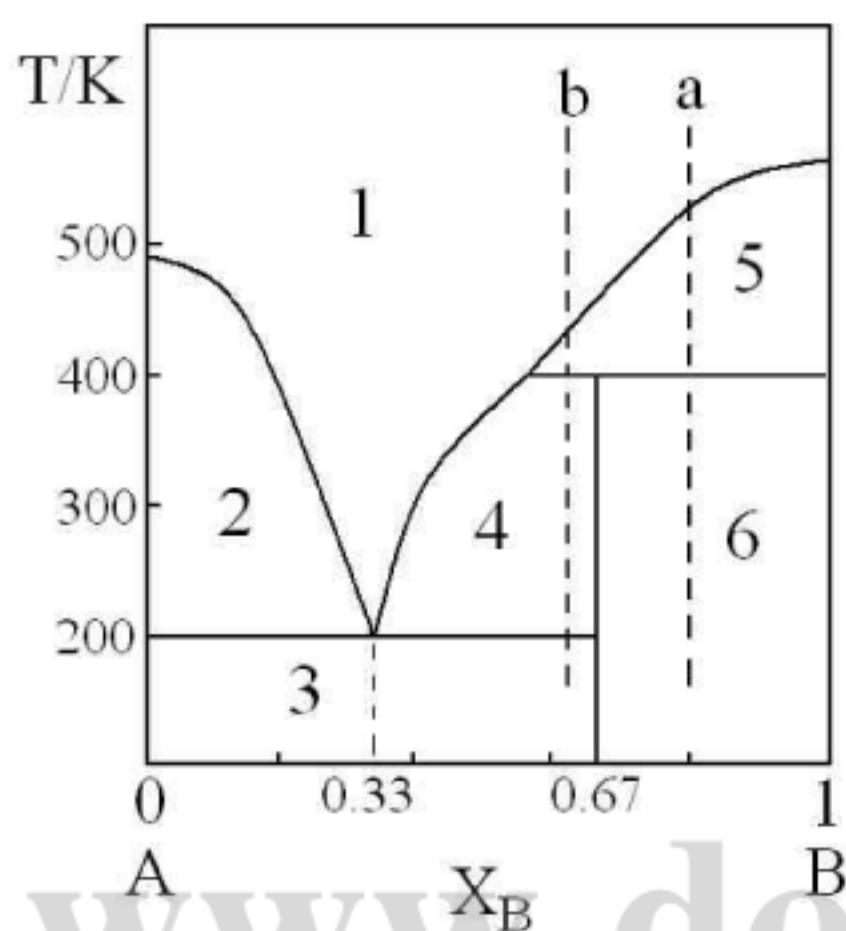
5. The standard Gibbs energies of formation for $HgCl_2(s)$, $Hg^{2+}(aq)$ and $Cl^-(aq)$ are -178.6, 164.4 and -131.2 $kJ \cdot mol^{-1}$, respectively. Calculate the molar solubility of $HgCl_2(s)$ at 298.2K. (15 scores)

6. On the basis of the following proposed mechanism, account for the experimental fact that the rate law of the reaction $2N_2O_5$ (g) $\rightarrow 4NO_2$ (g) + O_2 (g) is $k[N_2O_5]$.

$$N_2O_5 \xrightarrow{\quad k_1 \quad} NO_2 + NO_3$$
$$NO_2 + NO_3 \xrightarrow{\quad k_2 \quad} O_2 + NO$$
$$NO + NO_3 \xrightarrow{\quad k_3 \quad} NO_2 + NO_2$$

(a) Use the steady-state approximation to deduce the rate law for the formation of O_2 (g).

(b) Give the quantitative relationship between the activation energy E_a of the overall reaction and the activation energies E_1, E_{-1}, E_2 and E_3 of the elementary reactions if $k_{-1} << k_2$. (15 scores)

7. The adsorption of a gas is described by the Langmuir isotherm with the equilibrium constant $K = 0.85 \text{ kPa}^{-1}$ at 298.2 K. Calculate the pressure at which the fractional surface coverage is 0.95. (10 scores).