平成 27 年度　反応の化学b　学期末試験問題

以下の問に答えよ。数値は 3 桁まで求めよ。

問 1.

Partial Pressures and Mole Fractions

A 12.5-L scuba diving tank is filled with a heliox mixture containing 24.2 g of He and 4.32 g of O_2 at 298 K. Calculate the mole fraction and partial pressure of each component in the mixture and calculate the total pressure.

He の分子量 4.00, O_2 の分子量 32.00, 気体定数 R = 0.0821 L atm mol^{-1} K^{-1}.

問 2.

Calculating ΔG_{rxn} under Nonstandard Conditions

Consider the following reaction at 298 K:

$$2\,NO\,(g) + O_2(g) \longrightarrow 2\,NO_2(g) \quad \Delta G^\circ_{rxn} = -71.2\,kJ$$

Compute ΔG_{rxn} under the following conditions:

$$P_{NO} = 0.100\ atm;\ P_{O_2} = 0.900\ atm;\ P_{NO_2} = 6.00\ atm$$

Is the reaction more or less spontaneous under these conditions than under standard conditions?

気体定数 R = 8.31 J mol^{-1} K^{-1}.

問 3.

Anthropologists can estimate the age of a bone or other organic matter by its carbon-14 content. The carbon-14 in a living organism is constant until the organism dies, after which carbon-14 decays with first-order kinetics and a half-life of 5730 years. Suppose a bone from an ancient human contains 3.84% of the C-14 found in living organisms. How old is the bone?

Anthropologist;人類学者, carbon-14; 炭素の同位体 ^{14}C.

問 4.

Consider the following three-step mechanism for a reaction:

$$Cl_2(g) \underset{k_2}{\overset{k_1}{\rightleftharpoons}} 2\,Cl(g) \qquad \text{Fast}$$

$$Cl(g) + CHCl_3(g) \xrightarrow[k_3]{} HCl(g) + CCl_3(g) \qquad \text{Slow}$$

$$Cl(g) + CCl_3(g) \xrightarrow[k_4]{} CCl_4(g) \qquad \text{Fast}$$

a. What is the overall reaction?
b. Identify the intermediates in the mechanism.
c. What is the predicted rate law?

問 5.

Consider the following reaction at equilibrium:

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

Predict whether the reaction will shift left, shift right, or remain unchanged upon each of the following disturbances:

a. $COCl_2$ is added to the reaction mixture.
b. Cl_2 is added to the reaction mixture.
c. $COCl_2$ is removed from the reaction mixture.