【 July 2013 】

2013

Interdisciplinary Graduate School of Medicine and Engineering, Master Course, University of Yamanashi

Entrance Examination

No 1/1

Course or Program	Special Doctoral Program for Green Energy Conversion Science and Technology	Subject	Chemistry A

If necessary, the following values may be used when you solve the Questions 1-4:
Molar gas constant, R = 8.3 J K^{-1} mol^{-1}; Planck constant, h = 6.6×10^{-34} J s;
Speed of light, c = 3.0×10^{8} m s^{-1};
ln 2 = 0.69; ln 3 = 1.1; ln 5 = 1.6; ln 7 = 1.8; ln10 = 2.3

Question 1
Answer the following questions.
(1) A cylinder with a piston contains 1 mol of an ideal gas. A friction force is not exerted to the piston. Calculate the energy required when the ideal gas is compressed from 1 atm at 300 K to 10 atm at 300 K.
(2) A chemical reaction in a gas mixture at 300 K totally decreases the amount of the gas by 0.2 mol. The gas is assumed to behave ideally in a constant-pressure process. If the internal-energy change is −25 kJ, calculate the enthalpy change.

Question 2
(1) The vapor pressure of benzene is 0.13 atm at 27°C and 0.52 atm at 60°C. Calculate the molar enthalpy of vaporization, ΔH_{vap}.
(2) Answer the following questions.
2-1) Draw a pressure-temperature phase diagram of water.
2-2) Calculate the degree of freedom in the equilibrium state among water vapor, water, and ice.

Question 3
Suppose that rate constants are 0.001 and 0.003 s^{-1} at 800 and 1000 K, respectively, in a first-order reaction, answer the following questions.
(1) Calculate the half-life at 800 K.
(2) Calculate the activation energy of this reaction.

Question 4
Answer the following questions.
(1) Calculate the de Broglie wavelength for a ball (1.4×10^{-1} kg) traveling at 40 m s^{-1}.
(2) Calculate the ionization energy (kJ mol^{-1}) of the hydrogen atom. The empirical Rydberg formula is expressed by $\frac{1}{\lambda} = R_\infty\left(\frac{1}{n_1} - \frac{1}{n_2}\right)$ where R_∞ $=1.1\times10^{5}$ cm^{-1}.