2016

Integrated Graduate School of Medicine, Engineering, and Agricultural Sciences, Master Course, University of Yamanashi

Entrance Examination

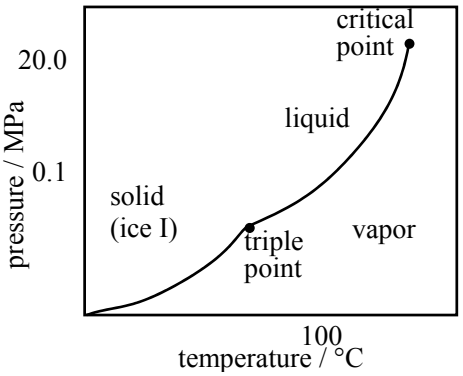
Course or Program	Special Doctoral Program for Green Energy Conversion Science and Technology	Subject	Chemistry A

Question 1

Standard fusion entropy $\Delta_{fus}S^0$ of H_2O is 22.0 $J \cdot K^{-1} \cdot mol^{-1}$. Answer the following questions.

(1) The ice I (solid of H_2O) fuses endothermically. Answer the reason of the endothermic reaction using standard fusion enthalpy.

(2) Density of solid (ice I) and liquid H_2O can be regarded as 0.92 and 1.00 $g \cdot cm^{-3}$ at around 0 °C, respectively. Answer whether the slope of border line between solid and liquid phase is positive or negative with appropriate explanation, and add the line into the right-hand side figure of the H_2O phase diagram.



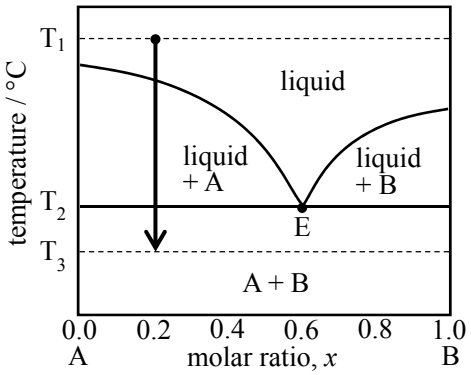
Question 2

For binary phase equilibrium diagram as showed bottom, answer the following questions.

(1) Answer the name of point E.

(2) The melt with the chemical composition of x = 0.2 at the temperature T_1 was cooled to T_3. Explain history of the phase change in the cooling process.

(3) After the cooling, the constituents will come to equilibrium at T_3. Estimate final component ratio of A and B in the sample.



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Question 3

Answer the following questions for the reaction $A \rightarrow P$ that follows the second-order reaction law. You may use t (reaction time), c_0 (initial concentration of the reactant A), c (concentration of A at time t), and k (rate constant), if necessary.

(1) Derive the rate equation of this reaction.

(2) Derive the half-life of the reactant.

(3) When c_0 is 10.0 mmol/L and c is 7.4 mmol/L at t = 100 min, calculate the rate constant and the half-life.

Question 4

Answer the following questions on the diatomic molecules, H_2, He_2, Li_2, and N_2.

(1) Write the electron configurations and calculate the bond orders of these molecules.

(2) Which of these molecules is (are) expected to be stabilized when they lose one electron? Explain the reason.

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Entrance Examination

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

Question 1

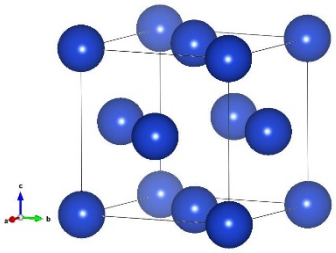

Fig. 1

Figure 1 shows a unit cell of platinum. Answer the following questions.

1-1) Draw the (1 1 1) lattice plane in this figure.

1-2) How many platinum atoms are there in the inside of the unit cell?

1-3) The X-ray diffraction line from the (1 1 1) lattice plane is observed at 2θ = 39.31 degree. Calculate the *d-spacing* of the (1 1 1) lattice planes. The wavelength of X-ray is 1.5418 Å.

1-4) Calculate the lattice parameter of platinum.

1-5) Calculate the density (g/cm^3) of platinum. Atomic weight of platinum is 195.08 and Avogadro number is 6.02×10^{23}.

Question 2

Answer the following questions.

2-1) Explain the difference of electric properties among an insulator, a semiconductor and a metal using their band structures.

2-2) Explain the Honda-Fujishima effect.

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

Entrance Examination

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

Use the following values if necessary: Faraday constant, F = 96500 C mol^{-1}; molar gas constant, R = 8.31 J mol^{-1} K^{-1}.

Question 3

The standard potential at 298 K is
+0.80 V for $Ag^+ + e^- \rightarrow Ag$

a) Calculate the standard electromotive force E° for $Pt|H_2(1\ atm)|H^+\|Ag^+|Ag$ at 298 K.
b) Describe the cell reaction (overall reaction). Calculate the standard Gibbs free energy change ΔG° for the cell reaction.
c) Write down the Nernst equation for the electromotive force E of the cell. Calculate the electromotive force E at 298 K, when the activity of Ag^+ is 0.0100 and the activity of H^+ is 0.100.

Question 4

The molar ionic conductivities at infinite dilution of Cu^{2+} and Cl^- are 1.07×10^{-2} and 7.6×10^{-3}
S m^2 mol^{-1} ($S = \Omega^{-1}$) at 298K.
a) Calculate the mobility $u°$ of each ion at infinite dilution.
b) Calculate the molar ionic conductivity of $CuCl_2$ solution at infinite dilution.
c) Calculate the transport number of each ion in the solution at infinite dilution.