**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 B |
|---|---|---|---|

Question 1

Answer the following questions

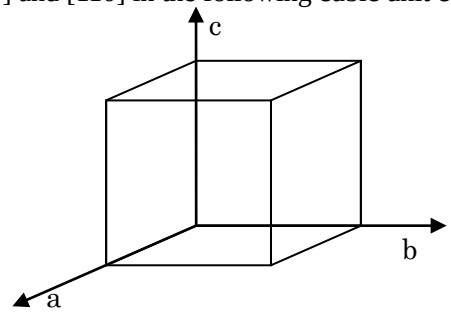
(1) For analysis of the crystal structure, both diffraction techniques by X-ray and electron are very useful. The electron diffraction can be obtained in TEM. Mention the difference between these diffraction techniques.

(2) Following diffraction lines, A and B, are generated from different lattice planes by X-ray with the same wavelength. Compare d-spacings and answer which one is larger?
A: first order diffraction at $\theta = 30°$, B: second order diffraction at $\theta = 60°$

Question 2

Answer the following questions

(1) Draw directions of [111], [200] and [110] in the following cubic unit cell.




(2) Explain the geometric relationship between lattice plane and direction of the same Millar indices. Place these Millar planes, (111), (200) and (110), in order of d-spacing decreasing.

Question 3

Answer the following questions

(1) Explain differences of insulator, intrinsic semiconductor and metal.

(2) Draw the band structure and the Fermi level of the intrinsic, n-type and p-type semiconductors, and explain differences of them.

(3) Answer what type of element should be doped into silicon for preparation of p-type silicon.

Question 4

Answer the following questions for silver halides

$AgCl + e^- \rightleftarrows Ag + Cl^-$ ($E^0 = +0.22$ V)
$AgBr + e^- \rightleftarrows Ag + Br^-$ ($E^0 = +0.07$ V)
$AgI + e^- \rightleftarrows Ag + I^-$ ($E^0 = -0.15$ V)
$Ag^+ + e^- \rightleftarrows Ag(s)$ ($E^0 = +0.80$ V)

(1) Calculate change of Gibbs free energy for dissolution of each silver halide, from the half cell reactions and the standard electrode potentials ($E^0$) as shown above. If necessary, use Faraday constant, $F$ = 96500 C $mol^{-1}$ and Molar gas constant, $R$ = 8.31 J $K^{-1}$ $mol^{-1}$.

(2) Calculate each dissolution product at 298 K and order them in solubility.

(3) Calculate the concentrations of $Ag^+$ in each pure aqueous solution.