

**Special Doctoral Program for Green Energy Conversion Science and Technology
Entrance Examination for 2013**

No _____

Course or Program	Special Doctoral Program for Green Energy Conversion Science and Technology	Subject	Inorganic Materials Science
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Question 1 Answer the following questions.

- (1) Explain how you can experimentally distinguish among α -quartz, SiO_2 glass, and silica gel.
- (2) Classify SiO_2 , BaO , Al_2O_3 , B_2O_3 , CaO , TiO_2 , P_2O_5 , Na_2O and K_2O as modifiers, intermediates or network formers and explain glass structure.
- (3) Explain crystallization of glass thermodynamically.

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Question 2

Answer the following questions about splitting of H₂O and photocatalytic materials.

- (1) Write the equations of H₂O splitting reaction by electrolysis on each electrode.

Anode :

Cathode :

- (2) Explain the essential requirements for a photocatalyst for overall H₂O splitting by visible light.

- (3) Band gap of cadmium sulfide, CdS, is approx. 2.5 eV. Estimate the color of the CdS. If necessary, use $h = 6.6 \times 10^{-34}$ Js, $c = 3.0 \times 10^8$ m/s and $1.0 \text{ eV} = 1.6 \times 10^{-19}$ J.

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Question 3

Answer the following questions as for a magnesium oxide (MgO) crystal. It has a cubic sodium chloride (NaCl)-type crystal structure with a lattice constant of 0.42 nm and a Z value of 4. The Z value of 4 indicates that Mg_4O_4 are included in the unit lattice.

(1) Calculate its density. The Avogadro constant is $6.0 \times 10^{23} \text{ mol}^{-1}$, and the atomic weights of Mg and O are 24 and 16, respectively.

(2) Supposing that the wavelength of X-ray (Cu $K\alpha$) is 0.15 nm, calculate the angle of the diffraction peak (110).

If necessary, the following values may be used;

$$\sqrt{2} = 1.4, \quad \sqrt{3} = 1.7, \quad \sqrt{5} = 2.2$$

$$\sin 10.5 = 0.18, \quad \sin 14.5 = 0.25, \quad \sin 17.5 = 0.30, \quad \sin 23 = 0.39$$

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Question 4

Answer the following questions about spectroscopic analyses.

- (1) Explain difference between Raman active and IR active for vibration of molecule.
- (2) In fingerprint region of IR spectra, what informations can we obtain from the spectra within the region?
- (3) Describe adequate methods for each measurement of IR spectra of powder, thin film on opaque substrate and colloid solution. Explain process of each method.