系所組別： 資源工程學系乙組

考試科目： 資源與材料工程基礎

考試日期：0219，節次：2

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

共有 150 分，請選 100 分作答，選答超過 100 分則倒扣。

I. 資源處理(Resources processing)

1. (1) Derive Newton equation for the terminal velocity? (5%)
(2) What factors affect the terminal velocity? (5%)

2. Please draw a schematic diagram to explain the theory of electric double layer and compare the difference between surface potential and zeta potential. (10%)

3. (1) What do you mean by the term liberation? Explain the theory of liberation by size reduction. (5%)
(2) Describe, giving suitable examples how the various properties of minerals are utilized for their beneficiation.(5%)

4. (1) What is the principle of flotation? (5%)
(2) What are Collectors? Classify them. Explain the mechanism of collection. (5%)

5. Explain the principle of magnetic separation and the factors that affect the magnetic separation. (10%)

II. 材料科學導論(Fundamentals of Materials Science)

6. Gibbs free energy and phase transformation

(1) Please explain the difference among unstable, metastable, and stable state using the schematic diagram of the variation of Gibbs free energy with position. (2%)

Silica occurs in a number of different forms in the earth. Figure 1 is the fields of stability, in pressure-temperature space, of the polymorphs of silica. Please explain:

(2) What type of phase transformation for cristobalite→tridymite→Quartz? (2%)

(3) What type of phase transformation for high Quartz→low Quartz? (2%)

(4) Cristobalite and tridymite both are high temperature phases. However, cristobalite and tridymite are often observed in room temperature. Please explain why? (2%)

(5) Which phase has the higher symmetry for high quartz and low quartz? Please explain it from the thermodynamics viewpoint. (2%)

(背面仍有題目,請繼續作答)

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

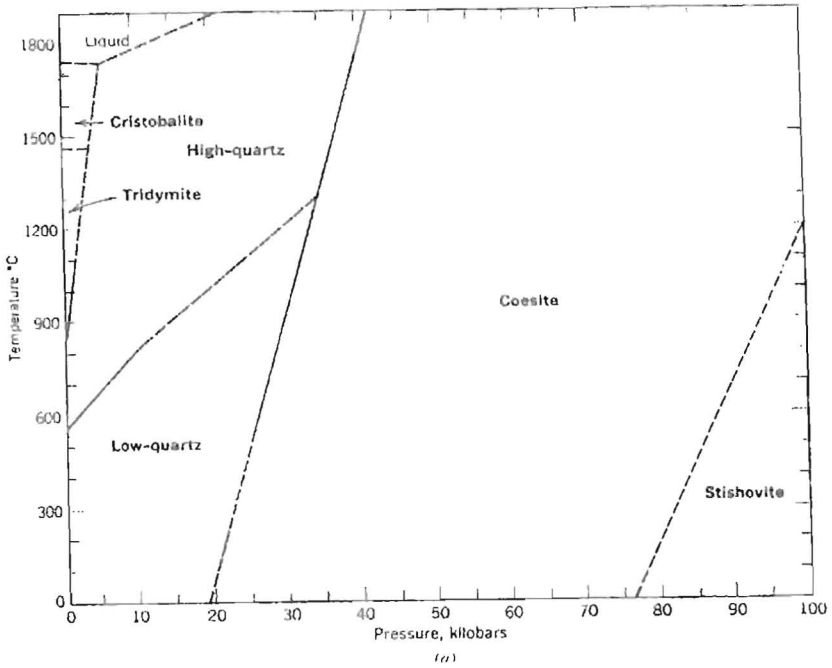

Fig.1

7. Define the followings by an appropriate equation (including the symbols used in the equation) or in several sentences:

(1)The types of intrinsic defect (2%)

(2)The factors affect the reaction rate of solid state reaction (2%)

(3)The types of mechanism of diffusion and which are more probable. (2%)

(4)Fick's 2nd law (2%)

(5)Kirkendall effect (2%)

8. A diffraction pattern of a cubic crystal of lattice parameter a = 3.16Å is obtained with a monochromatic X-ray beam of wavelength 1.54Å. The first line on this pattern was observed to have $\Theta=20.3^{\circ}$. Obtain the interplanar spacing and Miller indices of the reflecting plane. (10%)

9. Please explain the activation energy difference between the homogeneous and heterogeneous nucleation. (10%)

10. Barium titanate ($BaTiO_3$) is a ferroelastic and ferroelectric material. It has an exceptionally high dielectric constant and has been of great interest for its ferroelectric, piezoelectric and other electric properties. There are two different crystal systems reported for the barium titanate powders: cubic (c-) and tetragonal(t-). Moreover, it is found that c- $BaTiO_3$ which is considered

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

thermodynamically as the high-temperature form, exists at room temperature when the crystallite size is smaller than certain size. As the size of the c- $BaTiO_3$ increases, the c→t phase transformation occurs. The existence of c- $BaTiO_3$ at room temperature has been reported to be affected mainly by the crystallite size. Please explain why $BaTiO_3$ exists a critical size for the c→ t phase transformation from the consideration of thermodynamics. (10%)

III. 普通物理(General Physics)

11. (Nb, Ba)-doped TiO_2 ceramics were reported to be semiconductive ceramics and exhibit useful varistor properties with an nonlinear exponent (α) of about 3-4. Please explain the functions (donor or acceptor) of the additives, Nb^{5+} and Ba^{2+}, in the semiconductive TiO_2 ceramics and draw the schematic energy band diagrams for the (Nb, Ba)-doped TiO_2 ceramics (please label the energy levels of Nb^{5+} and Ba^{2+} substituting for Ti^{4+}). (10%)

12. Assume that the hydrogen atom is held together only by gravitational forces. What would be the radius of this hydrogen atom in the ground state? Calculate the photon wavelength emitted when an electron in the hydrogen atom transits from the n=2 state to the ground state (the ground state energy of the hydrogen atom is -13.6 eV, mass of the electron and proton are 9.1×10^{-31} and 1.67×10^{-27} kg, respectively). (10%)

13. An electron beam strikes a crystal of cadmium sulfide (CdS). Electrons scattered by the crystal move at a velocity of 4.4×10^5 m/s. Calculate the electron energy of the incident beam. Express your result in eV. CdS is a semiconductor with a band gap of 2.45 eV. (10%)

14. A 1.5 μF capacitor is charged to 57 V. The charging battery is then disconnected, and a 12 mH coil is connected in series with the capacitor so that LC oscillations occur. What is the maximum current in the coil? Assume that the circuit contains no resistance. (10%)

15. The potential energy (PE) per ion in an ionically bonded crystal can be expressed as

$$E(\cdot) = -\frac{e^2 M}{4\pi\varepsilon_o r} + B\exp\left(-\frac{r}{\rho_o}\right),$$

where r is the interionic separation, M is a constant (the Madelung constant) that

※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

depends on the crystal structure, and ρ_o and B are constants that characterize the repulsive force between two neighboring ions.

The energy per ion in the CsCl crystal is given by the above equation with $e=1.602\times10^{-19}$ C, $\varepsilon_o=8.85\times10^{-19}$ F m^{-1}, M= 1.76267, $B=4.512\times10^{4}$ eV and ρ_o = 0.034 nm. What is the equilibrium separation between the ions in the crystal? What is the binding energy (eV) per ion given that the ionization energy of Cs is 3.89 eV and the electron affinity of Cl is -3.61 eV (energy is released when the electron is put into Cl). (10%)