國立成功大學 107 學年度碩士班招生考試試題

系　　所：材料科學及工程學系

考試科目：材料熱力學　　考試日期：0205，節次：2

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

材料熱力學共 20 題選擇題，每題答對得 5 分，答錯倒扣 1 分；滿分 100 分，倒扣至 0 分為止。

1. At constant pressure, let enthalpy of a compound material AB=H_{AB}, entropy of AB=S_{AB}, enthalpy of the reaction A+B→AB (A and B are elements) =ΔH_{AB}, entropy of the reaction=ΔS_{AB}, and $\Delta c_{p,AB}=c_{p,AB}-c_{p,A}-c_{p,B}$. Which of the following statements is correct?

   (a) $H_{AB}(T2)$ is equal to $H_{AB}(T1)$

   (b) $\Delta S_{AB}(T2)=\Delta S_{AB}(T1)+\int_{T1}^{T2}\frac{\Delta c_{p,AB}}{T}dT$

   (c) $S_{AB}(298K)=\Delta S_{AB}(298K)$

   (d) $S_{AB}(T1)=H_{AB}(T1)/T1$

   (e) $\Delta S_{AB}(T1)=\Delta H_{AB}(T1)/T1$

2. The virial equation of state for hydrogen is $PV=RT(1-2\times10^{-4}P)$ [where "P" in atm]. One mole of nitrogen gas at 300K is isothermally compressed from 1 atm to 1000 atm. The fugacity of nitrogen at P=1000 atm is

   (a) 1221 atm　(b) 1000 atm　(c) 999.8 atm　(d) 818 atm　(e) 788 atm

3. Copper and gold form complete ranges of solid solution at temperatures between 410°C and 889°C. The activity coefficient of gold in the Cu-Au alloy is given (in joules) by the following equation: $RT\ln\gamma_{Au}=-28280X_{Cu}^2$. At $X_{Cu}=0.6$ and T=600°C, γ_{Cu}=

   (a) –1.403　(b) –0.624　(c) 0.098　(d) 0.246　(e) 0.536

4. A binary system with a miscibility gap (the critical temperature=T_c) can be modeled by a regular solution: $\Delta G^M=RT(X_A\ln X_A+X_B\ln X_B)+\Omega X_A X_B$. Then

   (a) at T_c, ΔG^M does not depend on composition

   (b) the miscibility gap is the temperature gap between T_c and room temperature

   (c) T_c depends on Ω

   (d) Ω must be smaller than zero

   (e) none of above is correct

5. The Ellingham line for the oxidation of silver ($2Ag_{(s)}+O_{2(g)}=2Ag_2O_{(s)}$) follows the equation of $\Delta G°=A+BT$ (B is positive) and $\Delta G°=0$ at T=462K.

   (a) The pressure of oxygen gas which is in equilibrium with pure silver at 462K, $p_{O2(eq.\ 462K)}$=1 atm.

   (b) The standard entropy change of for the reaction, $\Delta S°$ is positive.

   (c) Silver will not be oxidized at temperatures below 462K.

   (d) Silver will not be oxidized at temperatures above 462K.

   (e) None of above is correct.

6. A silver-gold alloy is a random mixture of gold and silver atoms. The gram atomic weights of Au and Ag are 198 and 107.6, respectively. When 10 g of gold are mixed with 20 g of silver to form a homogeneous alloy, the increase in entropy is _____ J/K

(a) -16.8 (b) -8.34 (c) 1.02 (d) 9.20 (e) 13.6

7. A CO_2-CO-H_2O-H_2 gas mixture at a total pressure of 1 atm exerts a partial pressure of oxygen of 10^{-7} atm at 1600°C. The Gibbs free energy of reaction $CO_2 + H_2 \rightarrow H_2O + CO$ at 1600°C is -142982 J. The ratio of CO_2/H_2 is _____.

(a) 0.1276 (b) 1.276 (c) 12.76 (d) 127.6 (e) 1276

8. The activity coefficient of Zn in liquid Zn-Cd alloys at 435°C can be represented as $\ln\gamma_{Zn} = 0.875X_{Cd}^{\ 2} - 0.30X_{Cd}^{\ 3}$. The activity of cadmium in the alloy of X_{Cd}=0.5 at 435°C is _____.

(a) 0.247 (b) 0.398 (c) 0.452 (d) 0.577 (e) 0.699

9. The partial molar Gibbs free energy of component *i* in solution can be expressed as,

(a) $\overline{G}_i = G_i^o - RT\ln X_i + RT\ln P$

(b) $\overline{G}_i = G_i^o + (RT\ln X_i)(RT\ln P)$

(c) $\overline{G}_i = G_i^o + RT\ln X_i - RT\ln P$

(d) $\overline{G}_i = G_i^o + RT\ln X_i + RT\ln P$

(e) $\overline{G}_i = RT\ln X_i + RT\ln P$

10. In a real gas system, when the van der Waals equation, $PV^3 - (Pb + RT)V^2 + aV - ab = 0$, is used and in comparison to ideal gas, the correction is applied due to

(a) no interaction between gas molecule

(b) gas molecule having its own volume

(c) pressure has no dependence on temperature

(d) van der Waals equation having nothing to do with ideal gas equation

(e) gas molecule having no volume.

11. In a diagram showing the variation of the change in the Gibbs free energy with respect to temperature for a metal oxidation reaction, the positive slope indicates that

(a) enthalpy is positive

(b) entropy is positive

(c) enthalpy is negative

(d)entropy is negative

(e) no dependence on both enthalpy and entropy

12.The Gibbs free energy of solution has the general correlation of

(a) $|\Delta G^{M}$ (positive deviation)$| > |\Delta G^{M,id}| < |\Delta G^{M}$(negative deviation)$|$

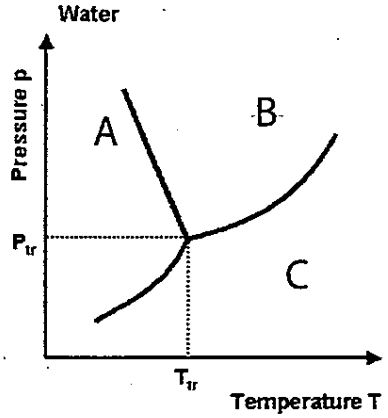
(b) $|\Delta G^{M}$ (positive deviation)$| < |\Delta G^{M,id}| > |\Delta G^{M}$(negative deviation)$|$

(c) $|\Delta G^{M}$ (positive deviation)$| = |\Delta G^{M,id}| < |\Delta G^{M}$(negative deviation)$|$

(d) $|\Delta G^{M}$ (positive deviation)$| < |\Delta G^{M,id}| = |\Delta G^{M}$(negative deviation)$|$

(e) $|\Delta G^{M}$ (positive deviation)$| < |\Delta G^{M,id}| < |\Delta G^{M}$(negative deviation)$|$

13. Unlike typical materials, water has a phase diagram like the following. Which statement is correct?



(a) The line between B and C has a critical point

(b) at low P and low T region (between A and C), it's called supercritical fluid

(c) A is liquid phase

(d) B is gas phase

(e) C is dense phase

14. Continue from Question 13, the major difference between water and typical materials is the line between A and B. This characteristic of water allows the following:

(a) water can freeze at 0°C

(b) ice can float on water

(c) a cotton line with weight can cut into ice

(d) steam can move pistons

(e) none of the above

15. If Cu and Ni form an ideal face-centered cubic solid solution at 1000 °C, which range of value in the following is the Gibbs free energy of mixing, ΔG^{M}, at $X_{Cu} = 0.5$ in J/mol? (Given: ln 2 = 0.69)

(a) $-12{,}000 \le \Delta G^{M} < -6{,}000$　(b) $-6{,}000 \le \Delta G^{M} < 0$　(c) 0

(d) $0 < \Delta G^{M} \le 6{,}000$　(e) $6{,}000 < \Delta G^{M} \le 12{,}000$

16. If Cu and Ni form an ideal face-centered cubic solid solution at 1000 °C, which range of value in the following is the mixing enrtopy, ΔS^M, at X_{Cu} = 0.25 in J/mol·K? (Given: ln 2 = 0.69)
(a) $-12 \le \Delta G^M < -6$ (b) $-6 \le \Delta G^M < 0$ (c) 0 (d) $0 < \Delta G^M \le 6$ (e) $6 < \Delta G^M \le 12$

17. Which of the following is a condition of a regular solution?
(a) Enthalpy of mixing equals to zero
(b) entropy of mixing equals to zero
(c) Gibbs free energy of mixing equals to zero
(d) entropy of mixing equals to entropy of mixing of an ideal solution
(e) none of the above is applicable

18. When Gibbs free energy is plotted as a function of temperature, a thermodynamic property may be obtained from the intercept at absolute zero
(a) the thermodynamic property is enthalpy
(b) the thermodynamic property is entropy
(c) it is a function of temperature
(d) it has always positive value
(e) none of above is correct

19. P_A^O and P_B^O represent the vapor pressures of pure A and B respectively. When A and B forms Henrian solution behavior with positive deviation, then the partial pressure of A, P_A, we will find
(a) $P_A^O / P_A = X_A$
(b) $P_A / P_A^O = kX_A$, k<1
(c) $P_A / P_A^O = X_A$
(d) $P_A / P_A^O = kX_A$, k>1
(e) $P_A / P_A^O = kX_A$, k=1

20. The initial state of one mole of a monatomic ideal gas is P = 10 atm and T = 300 K. The change in the entropy of the gas for a reversible adiabatic expansion to a pressure of 5 atm is
(a) 0 (b) 5.76 J/K (c) 15.75 J/K (d) 43.25 J/K (e) 104.78 J/K