國立成功大學 108 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：0223，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. For free expansion of one mole of an ideal monatomic gas, temperature remains constant. When the volume triples, which statement in the following is correct
   (a) the entropy change is negative
   (b) the enthalpy change is positive
   (c) the entropy change is zero
   (d) no heat involved in the process
   (e) none of above is correct

2. There is one mole of an ideal monatomic gas. When the temperature changes from 300K to 400K at constant volume, which statement in the following is correct,
   (a) no change in internal energy
   (b) no change in heat absorption
   (c) no work done
   (d) no change in entropy
   (e) none of above is correct

3. When two same chambers are separated by a partition, chamber 1 has 2 mole of gas A and chamber 2 has 1 mole of gas A. After removing the partition, these ideal gases do not interact and thus the total entropy change is
   (a) $\Delta S = 0$
   (b) $\Delta S = R\ Log\ [2]$
   (c) $\Delta S = 2\ R\ Log\ [4/3] - R\ Log\ [3/2]$
   (d) $\Delta S = 2\ R\ Log\ [3/2] + R\ Log\ [4/3]$
   (e) $\Delta S = 2\ R\ Log\ [4/3] + R\ Log\ [3/2]$

4. Which is a condition of an ideal solution?
   (a) enthalpy of mixing = 0
   (b) entropy of mixing = 0
   (c) Gibbs free energy of mixing = 0
   (d) Helmholtz free energy of mixing = 0
   (e) work = 0

5. Which activity coefficient is an indication of an "ordered" type solid solution?
   (a) < 1
   (b) > 1
   (c) = 1
   (d) < 0
   (e) = 0

6. Which activity coefficient is an indication of a "segregation" type solid solution?
   (a) < 1
   (b) > 1
   (c) = 1
   (d) < 0
   (e) = 0

7. For a binary system, what of the followings is true?
   (a) Maximum number of co-existing phases is four
   (b) triple point is invariant
   (c) minimum number of co-exiting phase is two
   (d) critical points are invariant
   (e) eutectic points are invariant

8. What of the followings is true?
   (a) A spinodal curve is equivalent to an immiscible gap.
   (b) An ideal mixture may phase separate at low temperatures.
   (c) The fugacity of a phase is defined based on its Helmholtz free energy.
   (d) A regular solution model can be expressed with the compressibility factor.
   (e) None of the above is applicable.

9. When the face-centered cubic (fcc) phase is in equilibrium with the body-centered cubic (bcc) phase in a binary system at constant temperature and pressure, what of the followings is true?
   (a) $a_A^{fcc}=a_B^{fcc}$
   (b) $a_A^{fcc}=a_A^{bcc}$
   (c) entropy of the system reaches the maximum
   (d) Gibbs free energy of the fcc phase reaches its minimum
   (e) none of the above is applicable

10. For the behavior of water, which of the following statements is correct?
   (a) the molar volumes of vapor phase and solid phase are equal to each other at the critical point
   (b) solid phase and vapor phase coexist at the critical point
   (c) vapor phase does not exist at 0°C
   (d) the molar volumes of liquid phase and vapor phase are equal to each other
   (e) the density of supercritical fluid is greater than its gas phase

11. For a multicomponent solution, which of the following expressions is correct? Q_i represents extensive property.
(a) $\sum n_i d\overline{Q_i} = 0$
(b) $\sum n_i / d\overline{Q_i} = 0$
(c) $\sum n_i Q_i < 0$
(d) $\sum n_i dQ_i = 0$
(e) $\sum d\overline{Q_i} = 0$

12. The van der Waals equation of state is given by $\left(P + \frac{a}{V^2}\right)(V - b) = RT$. What is the critical volume (V_{Cr}) expression of the van der Waals gas?
(a) V_{Cr} =2a
(b) V_{Cr} =2a/b
(c) V_{Cr} =3b
(d) V_{Cr} =2ab
(e) V_{Cr} =3ab

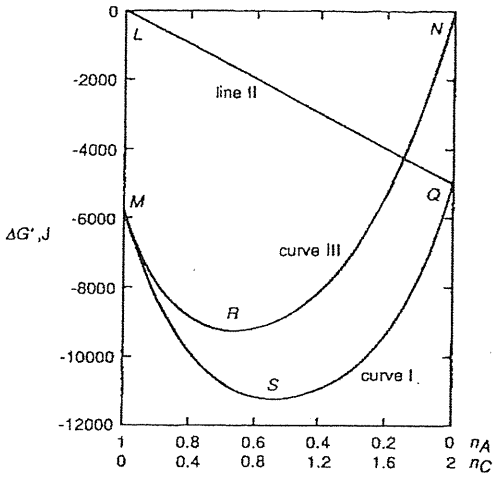
13. What is the change in enthalpy when one mole of SiC is heated from 25 °C to 1000 °C? The constant pressure molar heat capacity of SiC varies with temperature as $c_p = 50.79+1.97\times10^{-3}T- 4.92\times10^{6} T^{-2}$ J/mol-K
(a) 38384 J
(b) 39893 J
(c) 63674 J
(d) 49500 J
(e) 52260 J

14. Debye's model predicts that the molar constant-volume heat capacity
(a) is about 3R (R=gas constant) for ideal gas
(b) equals 0.5R as temperature approaches zero
(c) equals 9R at high temperature (T>> Debye temperature)
(d) depends on the Debye temperature
(e) is proportional to T^3 (T=absolute temperature) at low temperature

15. Assuming that a Au-Ag alloy is a random mixing of Au and Ag atoms, calculate the increase in entropy when 10 g of Au are mixed with 20 g of Ag to form a homogeneous alloy. The gram atomic weight of Au and Ag are, respectively, 198 and 107.9.
(a) 50 J/K
(b) 1.0 J/K
(c) 12.1 J/K
(d) 0.09 J/K
(e) 7.6 J/K
(Boltzmann constant, $k=1.38\times10^{-23}$ J/K)

16. For gaseous reaction $aA_{(g)} + bB_{(g)} = cC_{(g)} + dD_{(g)}$, which of the following is true?
(a) At equilibrium, **c+d > a+b**
(b) If **c+d > a+b**, the reaction moves in the left direction when pressure is increased
(c) The slope of K_p–**(1/T)** curve is $-\frac{\Delta H^0}{R}$
(d) The equilibrium constant K_p is dependent of pressure because $K_p = Exp[\frac{-\Delta G^0}{RT}]$
(e) When reaction reaches equilibrium, there is no reactant left

17. The variations of Gibbs free energy in the reaction $A_{(g)}+B_{(g)} = 2C_{(g)}$ is plotted in the Figure below, so we know:
(a) The reaction is endothermic.
(b) Due to stoichiometry, the number of moles $n_A = n_B = n_C$.
(c) If there is no reaction, the mixing of gases A and B reduces Gibbs free energy about 5900 joules.
(d) Curve **III** is the sum of Line **II** and Curve **I**.
(e) Line II indicates the initial status of the reaction.



18. In a gaseous reaction, which of the following is true?
(a) Since the mixture is highly nonideal, we cannot use fugacities to describe the gases.
(b) We can use *van't Hoff equation* to predict the pressure effect on K_p.
(c) The total number of moles of reactants equals to the total number of moles of products.
(d) If the reaction is exothermic, the equilibrium constant K_p increases with decreasing **T**.
(e) If there is catalyst in the system, the gases will reach complete reaction.

19. Using the ideal gas approximation, estimate the change in the total internal energy of 1.00 L of N_2 as p = 2.00 atm and T = 298.15 K if its temperature is increased by 10.0 K.
(a) 0.017 kJ
(b) 0.17 k J
(c) 1.70 kJ
(d) 17.0 kJ
(e) 170.0 k J

20. The entropy of a pure, perfectly crystalline substance at zero kelvin is _____ J/K.
(a) 0
(b) 10
(c) 100
(d) 1000
(e) 10000