國立臺北科技大學 100 學年度碩士班招生考試

系所組別：3301、3302 材料科學與工程研究所

第一節　普通熱力學　試題

注意事項：

1. 本試題共 A、B、C、D 四大題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

Section A. *Identify the following statements as either true or false. Use "O" for true and "X" for false. (If a statement requires some special condition to make it true, label it as false.)* 【45%】 (3 points each)

A1. For adiabatic reversible expansion of a nonideal gas, the entropy of system remains constant.

A2. For isothermal reversible expansion of an ideal gas, the internal energy of system remains constant.

A3. For an ideal gas, the internal energy and enthalpy are independent of the pressure and volume.

A4. The ΔG for a liquid water vaporized at 1 atm and $100^\circ C$ is positive.

A5. It is possible for an engine to perform work by cooling a portion of matter to a temperature below that of the coldest part of the surroundings.

A6. There is always an entropy increase during vaporization.

A7. At a given temperature, the change in helmholtz energy is equal to the non-PV work.

A8. According to Carnot's theorem, the efficiency of all reversible cycles operating between the temperatures T_h and T_c is the same.

A9. The term heat capacity is the amount of heat required to raise the temperature of unit mass of a material by $1\ ^\circ C$.

A10. For an ideal gas, the Joule-Thomson coefficient may be positive or negative.

A11. Mixing process usually results in an increase in entropy unless the mixture shows a negative deviation from Raoult's Law.

A12. All gases at sufficiently high pressure will have a compression factor larger than 1 since repulsive forces between molecules are dominant.

A13. According to Le Chatelier principle, diluting a solution by adding solvent will not change the equilibrium constant Kc.

A14. To have the result of "$\Delta H = 0$ for an isothermal process", ideal gas is a must condition.

A15. The entropy of a system will become zero at the absolute zero.

Section B. *Choose "one" correct answer for each of the followings.* 【20%】(4 points each)

B1. Heat capacity of an ideal gas is independent of

(a) pressure

(b) temperature

(c) molar number

(d) number of vibrational degree of freedom

B2. Under adiabatic condition, a gas expands against a constant external pressure of 3.0 atm to increase its volume from 1.4 liter to 5.8 liter. Due to this fact, which of the following statements is correct?

(a) the work was done on the gas

(b) the internal energy of the gas is decreased

(c) the temperature of the gas is increased

(d) the heat is absorbed by the gas

(e) the heat is released by the gas

B3. For an ideal gas compressed at constant temperature, which statement is true?

(a) $\Delta U = 0; \Delta G = 0$

(b) $\Delta U = 0; \Delta G < 0$

(c) $\Delta U = 0; \Delta G > 0$

(d) $\Delta U > 0; \Delta G > 0$

(e) $\Delta U < 0; \Delta G = 0$

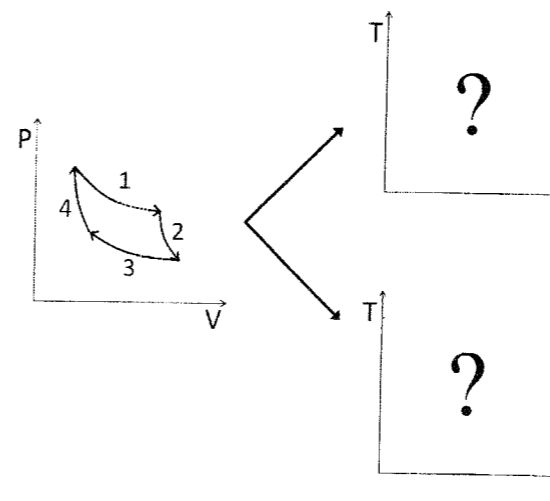**B4. Which of the following equation is NOT true for a reversible process?**

(a) $dU = PdV + TdS$

(b) $dH = VdP + TdS$

(c) $dG = VdP - SdT$

(d) $dA = -SdT - PdV$

B5. One mole of a perfect gas expands isothermally and reversibly against a pressure that is gradually reduced. Which one of following statements is correct for this case?

(a) $\Delta U = 0$; $\Delta H = 0$; $\Delta A = 0$

(b) $\Delta U = 0$; $\Delta A = 0$; $\Delta S = 0$

(c) $\Delta H = 0$; $\Delta A < 0$; $\Delta S = 0$

(d) $\Delta U = 0$; $\Delta A < 0$; $\Delta S > 0$

(e) $\Delta H = 0$; $\Delta A > 0$; $\Delta S > 0$

Section C. *Choose "one" correct answer for each of the followings.*【25%】(5 points each)

C1. Two moles of an ideal gas underwent a reversible isothermal expansion until its volume is tripled. If the gas performed 2 kJ of work, what was its temperature?

(a) 0.11 K　　(b) 11.4 K　　(c) 23.1 K　　(d) 84.2 K　　(e) 109.5 K　　(f) 219.0 K

C2. A chemical reaction occurs at 100 °C in a gas mixture that behaves ideally, and the total amount of gas increases by 0.1 mol. If $\Delta U = 1$ kJ, what will be the ΔH?

(a) 31 J　　(b) 83 J　　(c) 1000 J　　(d) 1031 J　　(e) 1083 J　　(f) 1310 J

C3. Exactly 10 liter of a 0.1 M solution of a substance A is added to 30 liter of a 0.05 M solution of a substance B. Assume ideal behavior and calculate the entropy of mixing.

(a) 15.1 J/K　　(b) -15.1 J/K　　(c) 14.0 J/K　　(d) -14.0 J/K　　(e) 5.6 J/K　　(f) -5.6 J/K

C4. Suppose that a cyclic machine operates between 600 K and 1000 K, and the initial heat absorbed by the machine is 1000 Btu. Which one of following work is NEVER to be possible for this machine to perform?

(a) 300 Btu　　(b) 400 Btu　　(c) 500 Btu　　(d) none of above

C5. At 100 °C and 5 bar pressure the degree of dissociation of a substance A is 10^{-5}. The dissociation reaction of substance A is shown in below. What is the K_c (concentration based equilibrium constant) for this reaction?

A (g) = B (g) + C (g)
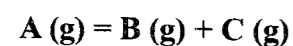
(a) 5.0×10^{-10} mol/L　　(b) 1.6×10^{-8} mol/L　　(c) 1.6×10^{-11} mol/L　　(d) none of above

Section D. *Explanations.* 【10%】 (5 points each)

D1. Consider an ideal gas that is carried through a Carnot cycle as shown in following diagram. Re-plot the diagram using other sets of coordinates of (a) T vs. P and (b) T vs. H. (Note that P: pressure; V: volume; T: temperature; H: enthalpy)