106MM01

國立臺北科技大學 106 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. 本試題共四題，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。

I. Identify the following statements as either true or false. Given "O" for true and "X" for false. (If a statement requires some special condition to make it true, label it as false.)【是非題：每小題 2 分，共 30 分】

1. The state of a system is independent of the history of the system.
2. Thermodynamics is based on empirical laws.
3. The entropy of any system remains constant when a reversible process occurs.
4. It is impossible for an engine to perform work by cooling a portion of matter to a temperature below that of the coldest part of the surroundings.
5. Whether a chemical or physical change can take place spontaneously is the concern of the third law of thermodynamics.
6. The absolute zero can be reached by the method of adiabatic demagnetization.
7. The ratio of the fugacity of a substance in any state to the fugacity in the standard state is known as the activity.
8. For the Carnot engine, its efficiency never can be 100%.
9. According to the theorem of Carnot, the efficiency of all reversible cycles operating between the temperature T_h and T_c is not the same.
10. Entropy is a state function.
11. There is always an entropy increase on melting process.
12. If a system changes from state A to state B by an irreversible process, we can still calculate the entropy change from the heat transfers that occur.
13. Latent heat of melting is a reversible heat.
14. Entropy changes become zero at the absolute zero.
15. The entropies of all perfectly crystalline substances must be the same at the absolute zero.

II. Multiple choice questions.【單選題：每小題 4 分，共 40 分】

1. For any cyclic process, which of the following meets the requirement of the Fist Law of Thermodynamics?

   (a) $\sum q_i = 0$　(b) $\sum w_i = 0$　(c) $(\sum q_i + \sum w_i) > 0$　(d) $(\sum q_i + \sum w_i) = 0$

   (e) $(\sum q_i + \sum w_i) < 0$

2. Heat capacity of an ideal gas is independent of

   (a) pressure

   (b) molar number

   (c) number of vibrational degree of freedom

   (d) temperature

3. In order to make the statement of "$\Delta G < 0$ *for a spontaneous process*" to be true, which of the following must be applied?

   (a) an ideal gas

   (b) a reversible process

   (c) isothermal process occurring at constant volume

   (d) isothermal process occurring at constant pressure

4. Which one is true for the reaction "H_2O (liquid) = H_2O (gas)" at 100 °C and 1 atm?

   (a) $\Delta H = T\Delta S$　(b) $\Delta H = 0$　(c) $\Delta S = 0$　(d) $\Delta H = \Delta G$　(e) $\Delta S < 0$

5. In a closed system, which of the following is NOT true?

   (a) $đw = -P_{int}dv$　(b) $đq_p = C_pdT$　(c) $C_v = (\partial U/\partial T)_v$　(d) $\Delta H = q_p$

6. If an ideal gas is expanded at constant temperature, which of the following is true?

   (a) $\Delta U = 0$ and $\Delta S = 0$　(b) $\Delta U > 0$ and $\Delta S = 0$　(c) $\Delta U > 0$ and $\Delta S < 0$

   (d) $\Delta U = 0$ and $\Delta S > 0$

7. Which of the following is not true as a Maxwell relation?

   (a) $\left(\frac{\partial H}{\partial S}\right)_P = V$　(b) $\left(\frac{\partial U}{\partial V}\right)_S = -P$　(c) $\left(\frac{\partial G}{\partial P}\right)_T = V$　(d) $\left(\frac{\partial A}{\partial V}\right)_T = -P$

注意：背面尚有試題

8. Which of the following is zero for all substances when the temperature goes to absolute zero?

   (a) sound velocity (b) electric resistance (c) free energy (d) none of above

9. By third law, the entropy of a solid at 1 atm pressure and temperature T is:

   (a) ΔH/T (b) $\int_0^T C_p dT/T$ (c) $\int_0^T C_p dT$ (d) $\int_0^T dq/T$

10. Which of the following is true for the reaction between H_2SO_4 and NaOH in dilute aqueous solution at constant temperature and pressure?

    (a) ΔG=0 (b) ΔU=0 (c) ΔH=0 (d) none of the above

III. Multiple choice questions.【單選題：每小題 5 分，共 20 分】

1. What is ΔS_{surr} about reversibly heating 1.0 mol of liquid water from 0 °C to 100 °C at a constant pressure of 1 atm?

   (a) -23.5 J K^{-1} (b) 23.5 J K^{-1} (c) -1.3 J K^{-1} (d) 1.3 J K^{-1} (e) 0 J K^{-1}

2. One mole of supercooled water at -10 °C and 1 atm pressure turns into ice. What is ΔS?

   (Take the heat capacities ($C_{P,m}$) of water and ice to be constant at 75.3 and 37.7 J K^{-1} mol^{-1}, respectively, and the latent heat of fusion of ice as 6020 J mol^{-1})

   (a) 21.4 J K^{-1} mol^{-1} (b) 2.8 J K^{-1} mol^{-1} (c) -1.4 J K^{-1} mol^{-1} (d) -20.6 J K^{-1} mol^{-1} (e) -22.0 J K^{-1} mol^{-1}

3. According to previous question (2), what is ΔS_{surr}?

   (a) 21.4 J K^{-1} mol^{-1} (b) 2.8 J K^{-1} mol^{-1} (c) -1.4 J K^{-1} mol^{-1} (d) -20.6 J K^{-1} mol^{-1} (e) -22.0 J K^{-1} mol^{-1}

4. What is the constant-volume molar heat capacity of liquid water at 0 °C and 1 atm?

   (The constant-pressure heat capacity is equal to 75.983 J $K^{-1}mol^{-1}$. The coefficient of thermal expansion is equal to -68.14×10^{-6} K^{-1}, which negative quantity is one of the few cases. The compressibility is equal to 50.98×10^{-6} bar^{-1}. The molar volume is equal to 18.012 cm^3 mol^{-1}.

   (a) 4.5×10^{-2} J K^{-1} mol^{-1} (b) 22.3 J K^{-1} mol^{-1} (c) -4.5×10^{-2} J K^{-1} mol^{-1} (d) 75.9 J K^{-1} mol^{-1} (e) -75.9 J K^{-1} mol^{-1}

IV. Calculation.【計算題：共 10 分】

1. The Joule-Thomson coefficient of air at 298 K and 25 atm is equal to 0.17 K atm^{-1}. If a Joule-Thomson expansion is carried out from a pressure of 101 atm to a pressure of 1 atm, estimate the final temperature if the initial temperature is equal to 298 K.