國立臺北科技大學 107 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. 本試題共兩大題，各有子題，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 50 分】

(1) The Kelvin statement of the Third Law is that no process is possible in which the sole result is the absorption of heat from a reservoir and its complete conversion into work.

(2) A spontaneous change is a change that does not require work to be done to bring it about.

(3) A change in entropy may be calculated by finding a reversible route between the specified initial and final states of a system.

(4) Trouton's rule states that a wide range of liquids have approximately the same standard entropy of vaporization (about 85 J K mol^{-1}).

(5) Entropy is a measure of the disorder of energy and matter.

(6) Entropy of any system remains constant when a reversible process occurs.

(7) The entropy of a perfect gas remains constant when it expands isothermally.

(8) The statistical definition of the entropy is given by the Boltzmann formula.

(9) The statistical entropy is a measure of the number of states that are occupied at a given pressure.

(10) Whether a chemical or physical change can take place spontaneously is the concern of the third law of thermodynamics.

(11) The Third Law of thermodynamics states that the entropy of all perfect crystalline substances is zero at T = 0.

(12) The Gibbs and Helmholtz energies provide criteria for spontaneity at constant volume and constant pressure, respectively.

(13) The change in the Helmholtz energy is equal to the maximum work accompanying a process at constant temperature.

(14) The change in the Gibbs energy is equal to the maximum non-expansion work accompanying a process at constant temperature and volume.

(15) The Maxwell relations relate the derivatives of thermodynamic state functions.

(16) The Gibbs-Helmholtz equation expresses the variation of G/T with temperature in terms of the enthalpy of the system.

(17) The Gibbs energy of a pure substance decreases when the temperature or the pressure is raised.

(18) In an adiabatic compression, the temperature falls as a perfect gas does work, and the pressure/volume relation is known as an adiabatic.

(19) The standard state is the pure substance at 1 atm.

(20) Hess's law states that the standard enthalpy of an overall reaction is the sum of the standard enthalpies of the individual reactions into which a reaction may be divided.

(21) The temperature dependence of the reaction enthalpy is given by Kirchhoff's law.

(22) The heat capacity at constant pressure is used to relate the change in enthalpy to a change in temperature.

(23) The Joule-Thomson effect is the cooling of a real gas by isenthalpic expansion.

(24) A closed system has a boundary through which neither matter nor energy can be transferred.

(25) Minimum work is achieved in a reversible change.

II. Multiple choice questions.【單選題：每小題 5 分，共 50 分】

(1) Find ΔS for the freezing of 5 g of liquid water at 0 °C and 1 atm? (heat of fusion = 79.7 cal g^{-1})

(a) 1.46 cal K^{-1}　　(b) -1.46 cal K^{-1}　　(c) 6.1 cal K^{-1}　(d) -6.1 cal K^{-1}　(e) none of above

(2) Calculate the work done when 100 g of $Fe_{(s)}$ reacts with $HCl_{(aq)}$ to produce $FeCl_{2(aq)}$ and $H_{2(g)}$ in a closed vessel of fixed volume at 298K. (Hint: $Fe_{(s)} + 2\ HCl_{(aq)} \rightarrow FeCl_{2(aq)} + H_{2(g)}$; molar mass of H is 1 g mol^{-1}; molar mass of Fe is 56 g mol^{-1}; molar mass of Cl is 35 g mol^{-1})

(a) -4.4 kJ　　(b) 4.4 kJ　　(c) -8.8 kJ　(d) 8.8 kJ　(e) none of above

(3) According to the above question (2), what will be the work done if the reaction ($Fe_{(s)} + 2\ HCl_{(aq)} \rightarrow FeCl_{2(aq)} + H_{2(g)}$) occurs in an open beaker at 298K.

(a) -4.4 kJ　　(b) 4.4 kJ　　(c) -8.8 kJ　(d) 8.8 kJ　(e) none of above

(4) As shown in the following figure, 0.1 mol of a perfect gas having $C_{v,m} = 1.5R$ independent of temperature undergoes the reversible cyclic process $1\rightarrow2\rightarrow3\rightarrow4\rightarrow1$, where either P or V is held constant in each step. What is the relation of the 4 temperatures, T1, T2, T3 and T4, corresponding to the states of 1, 2, 3 and 4, respectively?

($R = 8.314$ J mol^{-1} K^{-1} = 1.987 cal mol^{-1} K^{-1} = 82.06 cm^{-3} atm mol^{-1} K^{-1})
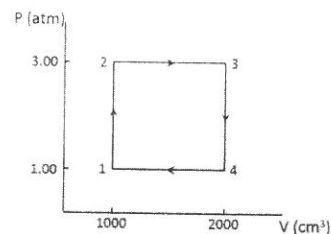
(a) T1 > T2 > T3 > T4　　(b) T1 > T2 > T4 > T3　　(c) T2 > T4 > T3 > T1　　(d) T2 > T4 > T1 > T3　(e) T3 > T1 > T2 > T4　(f) T3 > T2 > T4 > T1　(g) T4 > T1 > T2 > T3　(h) T4 > T3 > T2 > T1　(i) none of above

(5) According to the above question (4), what is the wok done due to the step from state 2 to state 3 ($w_{2\rightarrow3}$)?

(a) 0 J　(b) 304 J　(c) -304 J　(d) 203 J　(e) -203 J　(f) 101J　(g) -101 J

(6) According to the above question (4), what is the change of internal energy due to the step from state 1 to state 2 ($\Delta U_{1\rightarrow2}$)?

(a) 0 J　(b) 304 J　(c) -304 J　(d) 203 J　(e) -203 J　(f) 101J　(g) -101 J

(7) 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

(8) By third law, what is the entropy of a solid at 1 atm pressure and temperature T?

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

(9) Under adiabatic condition, a gas expands against a constant external pressure of 5.0 atm to increase its volume by 4.5 liter. According to this fact, which one of following statements is correct?

(a) the internal energy of the gas is not changed

(b) the temperature of the gas will be raised

(c) the heat was adsorbed by the gas

(d) the work was done by the gas

(10) In order to make the statement of "$\Delta H = 0$ for an isothermal process" to be true, which one of following conditions must be applied?

(a) An ideal gas

(b) A reversible process

(c) Isothermal process occurring at constant pressure

(d) Isothermal process occurring at constant volume