國 立 宜 蘭 大 學

１０９學年度研究所碩士班考試入學

物理化學(含熱力學與動力學)試題

（化學工程與材料工程學系碩士班）

准考證號碼：

《作答注意事項》

1.請先檢查准考證號碼、座位號碼及答案卷號碼是否相符。

2.考試時間：100 分鐘。

3.本試卷共有 9 題，共計 100 分。

4.請將答案寫在答案卷上。

5.考試中禁止使用手機或其他通信設備。

6.考試後，請將試題卷及答案卷一併繳交。

7.本試卷採雙面影印，請勿漏答。

8.本考科可使用非程式型（不具備儲存程式功能）之電子計算機。

9.試題最後一頁另備計算紙 1 張。

1. Explain the following items: (20%)
   (a) The first law of thermodynamics   (b) Ideal gas   (c) Law of corresponding states   (d) Chemical potential   (e) Phase rule.

2. Consider the reaction $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ carried out at 25 °C and 1 atm. Calculate $\Delta H°$, $\Delta S°$, and $\Delta G°$ using the following data.   (15%)

Substance	$\Delta H_f°$ (kJ mol^{-1})	$S°$ (J K^{-1} mol^{-1})
$SO_2(g)$	-297	248
SO_3 (g)	-396	257
$O_2(g)$	0	205

3. (a) Derive the Gibbs-Helmholtz equation $[\frac{\partial}{\partial T}(\frac{\Delta G}{T})]_P = -\frac{\Delta H}{T^2}$ from $\left(\frac{\partial \Delta G}{\partial T}\right)_P = -\Delta S$.

   (b) Derive the van't Hoff equation $\frac{d\ln K_P^o}{d(\frac{1}{T})} = -\frac{\Delta H^o}{R}$ from Gibbs-Helmholtz equation.   (10%)

4. A solution having composition p is cooled to just above the eutectic temperature (point s is about 0.18 x_{Si}, and x_e is 0.31 x_{Si}).   (15%)
(a) What is the amount of solid and liquid phase in percentage?
(b) Calculate the composition of the solid and the liquid.
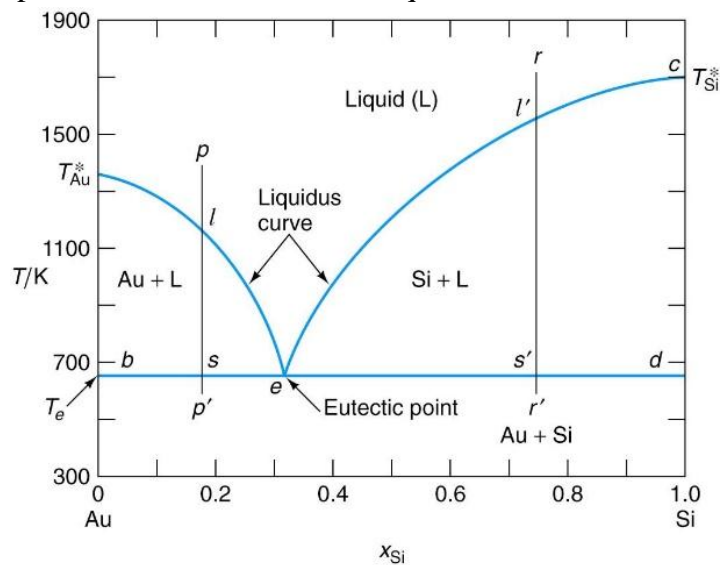
5. The turbine in a steam power plant takes steam from a boiler at 520 °C and exhausts it into a condenser at 100 °C. What is its maximum possible efficiency?   (5%)

6. (a) Derive the Clausius-Clapeyron equation $\ln\frac{P_2}{P_1} = \frac{\Delta_{vap}H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$.

   (b) Benzene has a normal boiling point at 760 Torr of 353.25 K and $\Delta_{vap}H_m$=30.76 kJ mol^{-1}. If benzene is to be boiled at 30.00°C in a vacuum distillation, to what value of P must the pressure be lowered?　(15%)

7. Exactly one liter of a 0.100 M solution of a substance A is added to 3.00 liters of a 0.050 M solution of a substance B. Assume ideal behavior and calculate the entropy of mixing.　(5%)

8. A certain first-order reaction has a half-life of 20.0 min.　(10%)
   (a) Calculate the rate constant for this reaction.
   (b) How much time is required for this reaction to be 75% complete?

9. The rate constant for a reaction at 230 ℃ is found to be exactly twice the value at 220 ℃. Calculate the activation energy.　(5%)