

一. 問答題 (20 分)

1. 一理想氣體經恆溫膨脹時, $\Delta U = q + w = 0$, 此系統對外界所作之功恰等於其自外界所吸收之熱量, 熱功轉換之效率 (efficiency) 為 100%, 試解釋為何並不違反第二定律?
2. 自然界中自混合物中分離出純物質常需給予額外的能量, 而混合物質則並不需要, 為什麼?
3. 試描述穩定膠體的方法, 試舉三種方法以說明之。
4. 已知 CO_2 之三相點 $T_{tr} = -56.6^\circ\text{C}$, $P_{tr} = 5.0 \text{ bar}$. 請問乾冰 (dry ice) 在室溫室壓下為何會昇華 (sublimation)?

二. (20%) A perfect monatomic gas of 1 m^3 at 273.2 K and 10 bar is expanded to a final pressure of 1 bar in (a) isothermal reversible, (b) adiabatic reversible, (c) irreversible adiabatic process. Calculate $q, w, \Delta U, \Delta H$, and ΔS in each process.

三. (12%) At 1273 K and at a total pressure of 30.4 bar the equilibrium in the reaction $\text{CO}_2(\text{g}) + \text{C}(\text{graphite}) = 2 \text{ CO}(\text{g})$ is such that $17 \text{ mol}\%$ of the gas is CO_2 . (a) What percentage would be CO_2 if the total pressure were 20.3 bar ? (b) What would be the effect on the equilibrium of adding N_2 to the reaction mixture in a closed vessel until the partial pressure of N_2 is 10 bar ? (c) At what pressure of the reactants will 25% of the gas be CO_2 ?

四. (8%) Calculate the surface area of a catalyst that adsorbs 103 cm^3 of nitrogen (calculated at 1.013 bar and 0°C) per gram in order to form a monolayer. The adsorption is measured at -195°C , and the effective area occupied by a nitrogen molecule on the surface is $16.2 \times 10^{-20} \text{ m}^2$ at this temperature.

五. α -石英 (低溫相) 在常壓下, 在 573°C 發生相變, 成為 β -石英 (高溫相), 其轉化熱為 18 Joules/g (吸熱反應)。根據下面之數據, 求此相變過程所產生的體積差及相對於室溫石英之平均線膨脹率。 (10 分)

壓力 (bars)	相變溫度 ($^\circ\text{C}$)
1	573
1000	599
5000	704
10000	815

* $1 \text{ bar} = 10^5 \text{ N/m}^2$

* 室溫石英之密度 = 2.65 g/cm^3

六. Al_2O_3 及 Cr_2O_3 在低溫時形成固溶體, 其熔點及熔融熱如下:

	熔點	ΔH_f
Al_2O_3	2050°C	108,800 J/mol
Cr_2O_3	2275°C	104,600 J/mol

試由以上數據計算並繪製 $Al_2O_3 - Cr_2O_3$ 二成分之 T-C 相圖. (10 分)

($R = 8.3144 \text{ J/deg.mol}$)

七. 參考下面之 $CaO - Al_2O_3 - SiO_2$ 相圖, 將組成為 X 點 (8.5% CaO , 49% Al_2O_3 , 44.5% SiO_2), Y 點 (11% CaO , 50% Al_2O_3 , 39% SiO_2), Z 點 (13.5% CaO , 50.5% Al_2O_3 , 36% SiO_2), 之粉末研細混合後, 緩慢加熱使反應保持平衡.

- (1) 各試樣將在什麼溫度開始出現液相? (3 分)
- (2) 各試樣將在什麼溫度全部熔融? (3 分)
- (3) 將熔融之熔液緩慢冷卻使保持平衡, 在此過程中, 各熔液之固相及液相部份組成如何變化? 最後固化後, 礦物組成及比例為何? (12 分)
- (4) 為什麼在 Pseudowollastonite 與 $CaO \cdot 6Al_2O_3$ 之間沒有 Alkemade 線? (2 分)

$CaO - Al_2O_3 - SiO_2$

