1. 何謂相律 (phase rule) (10%)

2. 下圖為一 two-component system, 由 Mg_2SiO_4 與 Fe''_2SiO_4 組成。

 a. 試問此二 components 是否生成理想溶液 (ideal solution) ?
 Why ? (5%)

 b. 將其人以各 50 (質量) %的Mg_2SiO_4 與Fe_2SiO_4 結晶粉末均勻混合, 再與加熱至 1,800°C時, 以相律來定義此時可得幾個相 ?這些相為何 ? (5%)

 c. 如由 1,800°C冷卻下來, 此系統中出現第一顆結晶的溫度挺幾度 ? 此結晶的化學成份為何 ? (10%)

 d. 在 1,600°C出現的結晶分子式為何 ? (10%)

 e. 在完全成為結晶時與結晶相伴之最後一滴液體, 其成份為何 ? (10%)
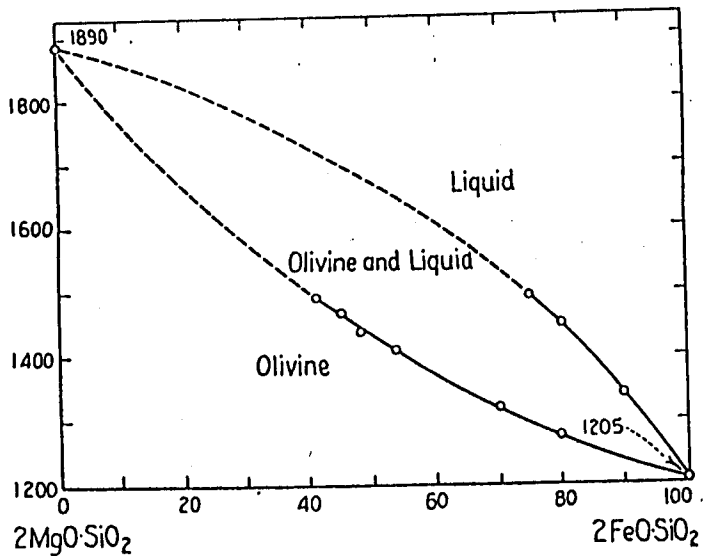
 (分子量: MgO: 40.3, FeO: 71.0, SiO_2: 60.1)

FIG. 250.—System $2FeO \cdot SiO_2$–$2MgO \cdot SiO_2$.

N. L. Bowen and J. F. Schairer, *Am. J. Sci.*, 5th Ser., 29, 163 (1935).

(背面仍有題目,請繼續作答)

3. 底下那些敘述是正確的? 如有不確, 請說明其原因。 (12%)
   a. The energy of an isolated system decreases when an irreversible process occurs in the system.
   b. The entropy of a sample of liquid water increases if it is evaporated at constant pressure.
   c. When an ideal gas expands through a throttle valve, the temperature will decrease.
   d. When an ideal gas expands isothermally into a vacuum, the internal energy must decrease.
   e. For an gaseous reaction
      $$A_{(g)} + 2 B_{(g)} = C_{(g)},$$
      the equilibrium will shift to the right side if the pressure is increased..
   f. For two metal oxides, AO_2 and BO, AO_2 can be more stable than BO at room temperature, if the enthalpy of formation $\Delta_f H_{AO_2} < \Delta_f H_{BO}$

4. 改變一物體的溫度常以熱容 (heat capacity) 表示, 並以定溫及/或定壓條件下量測。
   $$C_V \equiv \frac{d q_V}{dT} \quad , \quad C_p \equiv \frac{d q_p}{dT}$$

   試說明下列各題 :
   a. Show that $C_p - C_V = \left[P + \left(\frac{\partial E}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_p$ from the first law of thermodynamics $(i.e. dE = dq + dw)$ (6%)
   b. Is C_p always larger than C_V for any system? Explain the meanings of th two terms, $P\left(\frac{\partial V}{\partial T}\right)_p$ and $\left(\frac{\partial E}{\partial V}\right)_T\left(\frac{\partial V}{\partial T}\right)_p$ respectively. (6%)
   c. Show that $C_p - C_V = R$ for one mole of an ideal gas. (5%)

5. For the reaction $CH_4 + 2O_2 \rightarrow CO_2 + H_2O$,
   a. If the enthalpy of reaction at 25°C is given, any more data should you need then you can estimate the enthalpy of reaction at 1,000°C? (5%)
   b. When methane is oxidized completely to $CO_{2(g)}$ and $H_2O_{(l)}$ at 25°C, which process, I or II will produce more electrical energy? (6%)
      I. Using a fuel cell, assuming that there is no electrical losses.
      II. Using a Carnot engine which operates between 500 and 300K, assuming that the mechanical energy can be converted completely into electrical energy.

6. One mole of an ideal gas at 25°C and 10 bar is allowed to expand reversibly and isothermally to 1 bar. Calculate w, q, ΔH, ΔH, ΔS, ΔG and ΔA for this process. (10%)