※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. For the reaction, $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$, the dissociation pressure of $CaCO_{3(s)}$ versus temperature are shown as Fig. 1.

(a) How many degrees of freedom are there in the regions I, II, and III? State the phases in each region. (5%)

(b) Estimate the value of $\triangle G^{o}$ at 1000K. (5%)

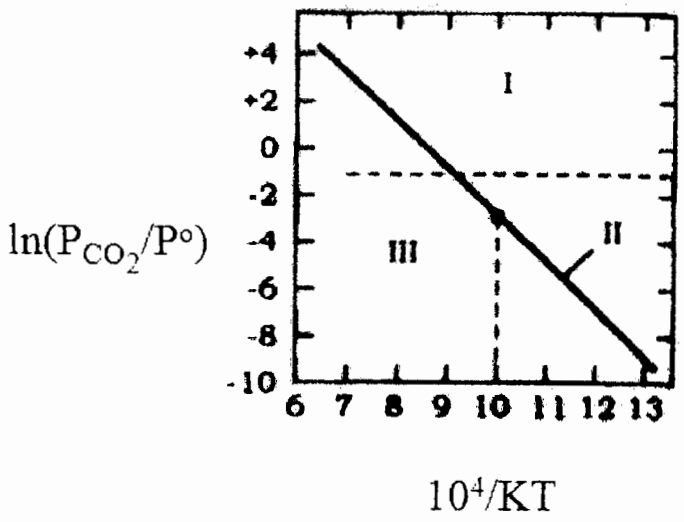

Fig.1

2. Figure 2 is the phase diagram of Na and K.

(a) What kind of reaction at point p and c? And state the reaction equation. (5%)

(b) Consider a specimen at point g with a composition of Na_2K, state the reaction sequence (at points of f, e, b, n,and a) as the specimen is cooled from g to a. (5%)

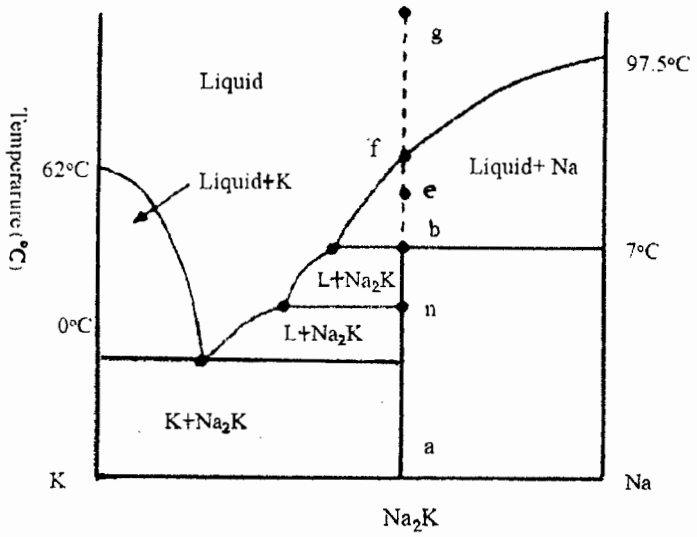

Fig.2

(背面仍有題目,請繼續作答)

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3. Plot a schematic diagram to explain the electric double layer and zeta potential. (10%)
4. A useful adsorption isotherm given by Brunauer, Emmett and Teller (BET) is expressed as:

$$\frac{1}{v\left[(p_0/p)-1\right]}=\frac{c-1}{v_{\mathrm{m}}c}\left(\frac{p}{p_0}\right)+\frac{1}{v_m c}. \qquad (1)$$

where p and p_0 are the equilibrium and the saturation pressure of adsorbates at the temperature of adsorption, v is the adsorbed gas quantity (for example, in volume units), and v_{m} is the monolayer adsorbed gas quantity. c is the BET constant.

(a) Suggest a method to test the applicability of equation (1), when v values are known at various pressures.(5%)

(b) Show that Eq.(1) reduces to Langmuir isotherm when $p_0 \geq p$. (5%)

(c) Show that for a small coverage of a system which obeys the Langmuir equation, the plot of ln(θ /P) against cp/p_0 is linear and has a slope of -1. (θ is the fraction of covered surface). (5%)

5. Explain why immiscible solution becomes complete miscible at a sufficiently high temperature in terms of Gibbs free energy. (5%)
6. For the cell Ag(*s*)|AgCl(*s*)| HCl(*aq*)|Hg_2Cl_2(*s*)|Hg(*l*), emf= 0.0455 volt at 25°C and temperature coefficient ($\partial E/\partial T$) = 0.338mV/K.
   (a) Write the individual electrode reactions and the overall cell reaction. (5%)
   (b) Evaluate ΔG, ΔH and ΔS for the cell reaction at 25°C for 1 F. (15%)
7. Determine the activation energy (E_A) for a reaction which triples upon a temperature increase from 20°C to 40°C. (10%)
8. Explain the difference among the insulators, n-type semiconductors, p-type semiconductors and metals in terms of band structures. (12%)
9. Use the Gibbs-Helmoltz equation

$$\left(\frac{\partial(\Delta G^{\ominus}/T)}{\partial T}\right)_p=-\frac{\Delta H}{T^2} \qquad (2)$$

to derive the Van't Hoff equation. (8%)