國立臺灣大學98學年度碩士班招生考試試題

1. (10%)
A sample of sucrose, $C_{12}H_{22}O_{11}$ weighing 0.1328 g, was burned to completion in a bomb calorimeter at 25 °C, and the heat evolved was measured to be 2186.0 J.
   (a) (5%) Calculate $\Delta_c U_m$ and $\Delta_c H_m$ for the combustion of sucrose.
   (b) (5%) Use data below to calculate $\Delta_f H_m$ for the formation of sucrose.

Substance	$\Delta_f H^o$ (kJ/mol)
$CO_{(g)}$	-110.53
$CO_{2(g)}$	-393.51
$CO_{2(aq)}$	-413.26
$CO_3^{-2}{}_{(aq)}$	-675.23
$H_2O_{(l)}$	-285.83
$H_2O_{(g)}$	-241.826

2. (12%)
A Carnot engine operates between 25 °C and 0 °C by using 1.00 mol of an ideal monatomic gas ($C_{v,m}$ = 1.5R). The initial pressure-volume conditions are 1.0 bar and 24.8 L. During the isothermal expansion step, the volume changes to 50.0 L. Calculate q, w, and ΔU for each step of the cycle and for the overall process.

3. (8%)
For the equation $Br_{2(g)} \rightarrow 2Br_{(g)}$, K = 38.4 at 2400 K and K = 84.7 at 2600 K. Assume ΔH^o is independent of temperature. Determine ΔG^o, and ΔH^o, ΔS^o, and K for this reaction at 2500 K.

4. (8%)
Diamonds have successfully been prepared by submitting graphite to high pressure. Calculate the approximate minimum pressure needed using $\Delta_f G = 0$ for graphite and $\Delta_f G = 2.9$ kJ mol^{-1} for diamond. The densities of the two forms may be taken as independent of pressure and are 2.25 and 3.51 g cm^{-3}, respectively.

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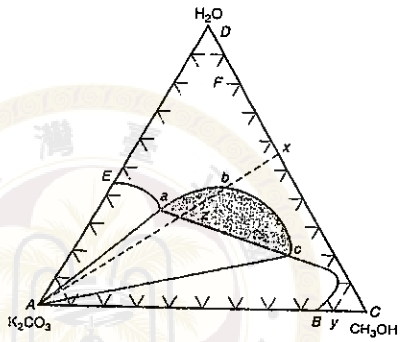
5. (12%)
In organic chemistry it is a common procedure to separate a mixture of an organic liquid in water by adding a salt to it. This is known as "salting out." The ternary system K_2CO_3-H_2O-CH_3OH is typical. The system is distinguished by the appearance of the two-liquid region *abc*.
   (a) (3%) Describe the phases present in each region of the diagram.
   (b) (3%) What would occur as solid K_2CO_3 is added to a solution of H_2O and CH_3OH of composition *x*?
   (c) (3%) How can the organic-rich phase in (b) be separated?
   (d) (3%) How can K_2CO_3 be precipitated from a solution having composition *y*?



6. (20%)
Explain (a) Le Chatelier's principal; (b) Raoult's Law; (c) Isoelectrical point; (d) Leonnard-Jones potential. (You may draw figure to explain)

7. (10%)
The gas –phase reaction, A → B + C is carried out isothermally in a 20 dm^3 constant-volume batch reactor. Twenty moles of pure A are initially placed in the reactor. The reactor is well mixed. (a) If the reaction is first order: $-r_A=kC_A$, with $k=0.865\ min^{-1}$, calculate the time necessary to reduce the number of moles of A in the reactor to 0.2 mol. (b) If the reaction is second order: $-r_A=kC_A^2$ with $k= 2\ dm^3/(mol\bullet min)$, calculate the time necessary to consume 19.0 mol of A.

8. (20%)
The following are the elemental steps of an enzyme reaction. Derive a rate equation ($- r_s$) involving competitive inhibition, in which the product acts an inhibitor as shown in the following,

$$E + S \underset{k_2}{\overset{k_1}{\longleftrightarrow}} E \bullet S$$

$$E + P \underset{k_4}{\overset{k_3}{\longleftrightarrow}} E \bullet P$$

$$E \bullet S \xrightarrow{k_r} E + P$$

Where E: enzyme, S: subtract, P: product

If the rate equation is in a form of Michaelis-Menten equation, what will K_m be?

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