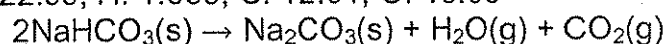考生注意事項：
一、考試時間 100 分鐘。
二、請考生自填準考證號碼。
三、可使用工程用計算機。

試題一：〈18%, 2/each 1〉
    P: pressure; T: temperature; V: volume; W: work; Q: heat; U:internal energy; H: enthalpy; S: entropy; G: Gibbs energy; A: Helmholtz energy.
If a system just do the P-V work, please fill in the blanks.

	Spontaneous (irreversible) process	Equilibrium (reversible) process
$(dS)_{V,U}$	> 0	= 0
(dU)___,___	___0	___0
(dA)___,___	___0	___0
(dG)___,___	___0	___0

試題二：〈12% 6/ each 1〉
    Na: 22.99; H: 1.008; C: 12.01; O: 16.00
        $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(g) + CO_2(g)$
    Sodium bicarbonate($NaHCO_3$) is called baking soda because when heated, it releases carbon dioxide gas, which causes cookies, doughnuts, and bread to rise during baking. Calculate (a) the amount (in mols)   (b) the volume (in liters) of CO_2 produced by heating 5.0 g of $NaHCO_3$ at 180℃ and 1.3 atm.

試題三：〈10 %, 5/ each 1〉
    When the concentration of A in the reaction A → B was changed from 1.2 M to 0.60 M , the half-life increased from 2.0 min. to 4.0 min. at 25℃. Calculate the order of the reaction and the rate constant.

試題四 : 〈10%〉
　　A Dumas experiment to determine molar mass is conducted in which a gas sample's P, θ, and V are determined. If a 1.08 g sample is held in 0.250 dm^3 at 303 K and 101.3 kPa.

試題五 〈20%,10/ each 1〉
A sample of liquid benzene weighing 0.633 g is burned in a bomb calorimeter at 25℃, and 26.54 kJ of heat are evolved. (a) Calculate $\triangle$U per mole of benzene. (b) Calculate $\triangle$H per mole of benzene.

試題六 : 〈10%, 2/each 1〉
For each of the following processes, state which of the quantities $\triangle$U, $\triangle$H, $\triangle$S, $\triangle$A, and $\triangle$G are equal to zero:
　　　(a) Isothermal reversible expansion of an ideal gas.
　　　(b) Adiabatic reversible expansion of a nonideal gas.
　　　(c) Vaporization of liquid water at 80℃ and 1 bar pressure.
　　　(d) Vaporization of liquid water at 100℃ and 1 bar pressure.
　　　(e) Reaction between H_2 and O_2 in a thermally insulated bomb.

試題七 : 〈10%〉
Derive expressions for (a) α (expansion coefficient) and (b) κ (isothermal compressibility coefficient) for an ideal gas.

試題八 : 〈10%〉
In a study of the osmotic pressure of hemoglobin at 276.15 K, the pressure was found to be equal to that of a column of water 3.51 cm in height. The concentration was 1 g per 0.100 dm^3. Calculate the molar mass.