

中原大學 107 學年度碩士班考試入學

107/3/7 10:10 AM~11:40 AM

化學工程學系

誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你！

科目：熱力學及動力學

(共 2 頁，第 1 頁)

■可使用計算機(僅限於四則運算、三角函數及對數等基本功能，可程式之功能不可使用)

□不可使用計算機

-----(不可直接作答於試題，請作答於答案卷)-----

(20%) Problem 1: True/False and short answer. (please provide an explanation)

(1) **True/false:** A and B liquids are miscible (spontaneously). Therefore, the mixing process is impossible to be exothermic when mixing these two liquids. $\Delta G = \Delta H - T\Delta S$ (5%)

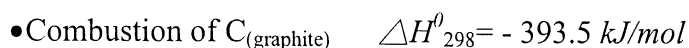
(2) **True/false:** The Joule-Thomson coefficient (μ_{J-T}) for nitrogen is 2.15 K/MPa at 298K and 1 atm. If the valve on a cylinder of compressed nitrogen at 298 K is opened fully, the temperature of valve will increase. (5%)

(3) **True/false:** For any **spontaneous** process, the entropy change of the system must be greater than zero. (5%)

(4) **Short answer:** An inventor has devised a heat engine. The net effect of the cyclic process is to produce 200 J of work from 200 J of heat released from a combustion process. Is the claimed performance of the heat engine possible? (5%)

(15 %) Problem 2

Please calculate the standard enthalpy of formation for ethane, $\Delta H^0_{(\text{formation})}(\text{C}_2\text{H}_6, \text{g})$, at 298K by using the following three combustion reactions at 298K.



(15 %) Problem 3

For a closed system with **1.5 kg water** as the surroundings, a mole of real gas (system) undergoes a **cyclic and** constant-pressure process. As a result, the system gets **89.1 kJ** of work. The initial temperature of water is 300 K.

(1) Calculate the change in internal energy (ΔU). (7 %)

(2) What is the temperature of water after the **cyclic** process? (8%)

(The C_p of water is $4.18 \text{ J g}^{-1} \text{ K}^{-1}$)

$$q_p = \int_{T_{\text{sys},i}}^{T_{\text{sys},f}} C_P^{\text{system}}(T) dT = -C_P^{\text{surroundings}} \Delta T$$

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(15%) Problem 4

Please explain the following terms in chemical reaction engineering field.

- (1) PFR (5%)
- (2) Residence time. (5%)
- (3) Stoichiometric coefficient (5%)

(20%) Problem 5

The rate constants for hydrolysis of penicillin were $7 \times 10^{-4} \text{ s}^{-1}$ at 22.2°C and of $2 \times 10^{-3} \text{ s}^{-1}$ at 38°C according to a recent measurement.

- (1) What was the order of the reaction? (3%)
- (2) Calculate the activation energy and the pre-exponential factor, assuming the Arrhenius equation to apply (10%).
- (3) Draw the Arrhenius plot (4%), and predict the rate constants of this reaction at 30°C . (3%)

(15%) Problem 6

Consider the following sequential reaction scheme composed of two elementary reactions:



Assuming that only A is present at the initial condition using **steady state approximation**.

- (1) Explain the term **steady state approximation**. (3%)
- (2) If steady state approximation is applicable, which of the elementary reaction would be the rate determining step? (2%).
- (3) What is the expected time dependence of [P] (10%)?