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 ($\mu_{J\text{-}T}$) 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, $\triangle H^0_{(formation)}(C_2H_6, g)$, at 298K by using the following three combustion reactions at 298K.

- Combustion of $C_{2}H_{6(g)}$ $\triangle H^0_{298} = -1560\ kJ/mol$
- Combustion of $C_{(graphite)}$ $\triangle H^0_{298} = -393.5\ kJ/mol$
- Combustion of $H_{2(g)}$ $\triangle H^0_{298} = -286\ kJ/mol$

(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 J g^{-1} K^{-1})

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

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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 7×10^{-4} s^{-1} at 22.2°C and of 2×10^{-3} 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:

$$A \xrightarrow{k_A} I \xrightarrow{k_I} P$$

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%)?