國立雲林科技大學 109 學年度
碩士班招生考試試題

系所：化材系
科目：單元操作與輸送現象

1. (a) What are the limitations of Bernoulli's equation? (5%)
   (b) What is NPSH (Net Positive Suction Head)? (4%)
   (c) What is the Hagen-Poiseulle equation? How do you use the Hagen-Poiseulle equation to measure viscosity of a fluid? (6%)

2. There is a tank, 1 meter in diameter and 3 meters high, filled with water. Water is now drained out through the small hole at the bottom of the tank. The diameter of the small hole is 4 cm. The relationship between the average flow velocity u_o of water flowing through the small holes and the height of the water surface in the tank is $u_o = 0.62\sqrt{2gz}$.
   (a) Assume that the density of water is 1000 kg/m^3. How long will it take to release 1 m^3 of water? (10%)
   (b) If the water in the tank is changed to kerosene, the density of kerosene is assumed to be 800 kg/m^3. If other conditions remain the same, how long will it take to release 2 m^3 of kerosene? (5%)

3. Water at 68 ^{o}F (ρ = 62.4 lb_m/ft^3, μ=1 0.76$\times 10^{-3}$ lb_m/ft-s) is flowing through a 3 inches inside diameter smooth pipe of 200 feet, at a mean velocity of 4 ft/s. The friction factor is following the expression: $f = \frac{0.0791}{Re^{0.25}}$. If the outlet of the pipe is 5 feet higher than the inlet, determine the power required to obtain this flow rate. (20%)

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4、Please explain the following terms:

(a)Thermally fully developed conditions (3%)

(b)Forced convection (3%)

(c)Peclet number (3%)

(d)Prandtl number (3%)

(e)Fick's law of diffusion (3%)

5、The temperature distribution across a plane wall of 0.25m thick at a certain instant of time is $T(x)=190-160x+30x^2$ where T is in degree Celsius and x is in meters . The wall has a thermal conductivity of 1.2 W/(m . K) .

(a)On a unit surface area basis , estimate the rate of change stored by the wall . (7%)

(b)If the cold surface is exposed to a fluid at 120 °C , What is the convection coefficient ? (8%)

6、Hot air flows with a mass rate 0.05 kg/s through an uninsulated sheet metal duct of diameter D = 0.15m , which is in the crawl space of a house . The hot air enters at 376 K and , after a distance of L = 5m , cools to 350K . The heat transfer coefficient between the duct outer surface and the ambient air at $T_\infty = 273$ K is known to be $h_0 = 6$W/(m^2 . K)

(a)Please calculate the heat loss from the duct over the length L= 5m (10%)

(b)Determine the heat flux and duct surface temperature at L= 5m (10%)

〔Given：1.air(T_m=363K)：C_p= 1010 J/(kg . K)；air(T_m=350K)：k = 0.03W/(m . K)，$\mu = 2.08 \times 10^{-5}$ N . s / m^2 ，Pr = 0.7；2. $Nu_D = 0.023\, Re_D^{4/5} Pr^n$ for turbulent flow in circular tube and n=3 for cooling ，n=4 for heating〕

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1. Calculate the entropy change for the reversible and isothermal expansion (V_i to V_f) of n moles gas [C_V (heat capacity of constant volume) = constant] which is in a closed system and obeys the following equation of state :

$P(V - b) = nRT$ where b = constant (18 %)

2. $\left(\frac{\partial U}{\partial T}\right)_P = C_V$ for a perfect gas , show that

$C_{P,m} - C_{V,m} = R$ (12 %)

3. The equilibrium constant for the following reaction is 0.164 at 298 K.

$$I_{2(s)} + Br_{2(g)} <=> 2\,IBr_{(g)}$$

Bromine gas is introduced into a container with excess solid iodine. The pressure and temperature are held at 0.164 atm and 298 K, respectively. Assume that the vapor pressure of solid iodine is negligible and that all gases are perfect gases. Calculate $\Delta_r G^0$ (J/mole) and the partial pressure (atm) of $IBr_{(g)}$ at equilibrium for the above reaction. ($R = 8.314\ J\ K^{-1}\ mol^{-1}$) (20 %)

4. Definition: (10%)
1) Entropy $\Delta S > 0$
2) The second law of thermal dynamics
3) Partial properties
4) Raoult's law
5) Fugacity coefficient

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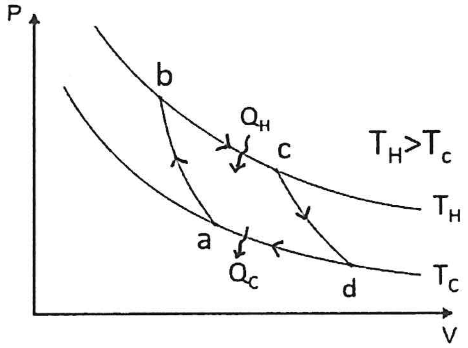
系所：化材系

科目：物理化學

5. Please derive $\eta = 1 - \frac{T_c}{T_H}$ by Carnot's theorem with the following figure.

(20%)



6. Please derive Gibbs-Duhem equation with constant pressure and constant temperature. (20%)

$$\sum x_i d\overline{M_i} = 0$$

國立雲林科技大學 109 學年度 碩士班招生考試試題
系所：化材系
科目：化工熱力學

1. An ideal gas, initially at 300 K and 2.5 bar, undergoes reversible and cyclic processes in a closed system. It is first compressed adiabatically to 8.2 bar, then cooled at a constant pressure to 300 K, and finally expanded isothermally to 2.5 bar. Let $C_P = 3.5R$ and $C_V = 2.5R$. Calculate W, Q, ΔU, and ΔH for each step of the cyclic processes. (20%)

2. 14.0 mol s^{-1} of nitrogen, $C_P = 3.5R$, is compressed in a steady-flow compressor. Temperatures and velocities are: $T_1 = 320$ K, $T_2 = 480$ K, $u_1 = 12.4$ m s^{-1}, and $u_2 = 2.6$ m s^{-1}. Delivered mechanical power is 110.2 kW. Calculate the rate of heat transfer from the compressor. (14%)

3. An ideal gas, $C_P = 3.5R$, is heated in a steady-flow heat exchanger from 325 K to 385 K by another stream of the same ideal gas which enters at 500 K. The flow rates of the two streams are the same, and heat losses from the exchanger are negligible. (a) Calculate the molar entropy changes of the two streams for parallel flow in the exchanger; (b) What is ΔS_{total}? (16%)

4. Residual mixing entropy S and residual mixing Gibbs energy G are both function of compressibility-factor Z, please show their relationship of Z and how to obtain them. (18%)

5. The enthalpy of a binary liquid system of species 1 and 2 at fixed T and P is represented by the equation: $H=200X_1+300X_2+X_1X_2(20X_1+10X_2)$

   Where H is in J/mol. Determine expressions for $\overline{H}_1$ and $\overline{H}_2$ as function of X_2, numerical values for the pure-species enthalpies H_1 and H_2, and numerical values for the partial enthalpies at infinite dilution $\overline{H}_1^{\infty}$ and $\overline{H}_2^{\infty}$. (12%)

6. (a) Please explain what physical meanings of fugacity, fugacity coefficient, activity, and activity coefficient are, respectively? Please write their difference between pure i specifies and species i in solution. (b) Please show how to gain the modified Raoult's Law. (20%)

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碩士班招生考試試題

系所：化材系
科目：化工動力學

1. In a batch reactor, after operation for 7 minutes, reactant (C_{A0} = 1 mol/liter) is 70 % converted. However, after 27 minutes, reactant conversion reaches 90 %. Find a rate equation to represent this reaction. (25%)

2. The hypophosphorous acid (H_3PO_2) is transformed into phosphorous acid (H_3PO_3) under the influence of oxidizing agent. The kinetics of this transformation present the following features. At a low concentration of oxidizing agent,

$$\gamma_{H3PO3} = k\,[\text{oxidizing agent}]\,[H_3PO_2]$$

At a high concentration of oxidizing agent,

$$\gamma_{H3PO3} = k'\,[H^+]\,[H_3PO_2]$$

To explain the observed kinetics, it has been postulated that, with hydrogen ions as catalyst, normal unreactive H_3PO_2 is transformed reversibly into an active form, the nature of which is unknown. This intermediate then reacts with the oxidizing agent to give H_3PO_3.

(a) Write a two-step mechanism based on the above description. (10%)

(b) Derive the rate law (γ_{H3PO3}) for the mechanism in (a), stating any assumption made. (15%)

3. For a first-order liquid-phase irreversible reaction,

(a) Show the Damköhler number (Da) in terms of 'space time' for this reaction if Damköhler number is defined as the following equation. (4%)

$$\text{Da} = \frac{-r_{A,0} \cdot V}{F_{A,0}} = \frac{\text{Rate of reaction at entrance}}{\text{Entering flow rate of A}}$$

(b) Express the conversion rate of this reaction in a single CSTR in terms of 'Damköhler number'. (10%)

(c) Derive the conversion rate of this reaction in terms of 'Damköhler number' if 5 equal-sized CSTRs connected in series with the same volumetric flowrate under the same operating temperature. (10%)

(d) Considering numerous equal-sized CSTRs connected in series, determine how many reactors are required to reach 80% conversion if (case I) Da = 1.0 and (case II) Da = 0.1. (6%)

4. Suppose a liquid-phase reaction (A → B + C) was carried out isothermally and the data were obtained as following:

Conversion, X	0	0.2	0.4	0.6	0.8
$-r_A$ (kmol/m^3·hr)	73	60	25	8	5

The molar flow rate is 20 kmol/hr.

(a) For a single CSTR, what is the volume necessary to achieve 80% conversion of the entering species A? (4%)

(b) For the two CSTRs in series, 40% conversion rate is achieved in the first reactor. What is the volume of each of the two reactors necessary to achieve 80% overall conversion of the entering species A? (8%)

(c) Followed by part (b), determine the volume of PFR if it is used to replace the second CSTR. (8%)

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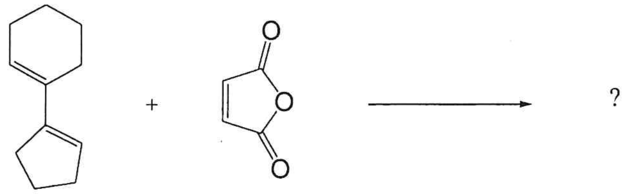
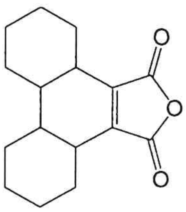
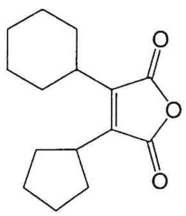
1. **What is the product of the following Diels-Alder cycloaddition reaction:**

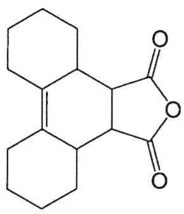




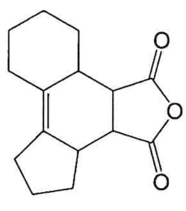
I



II



III



IV

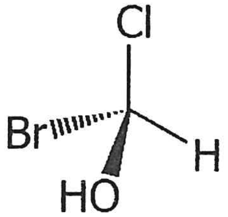
(a) I; (b) II; (c) III; (d) IV; (e) none of these choices. (3%)

2. **Define acid and base according to Brönsted-Lowry theory. (6%)**

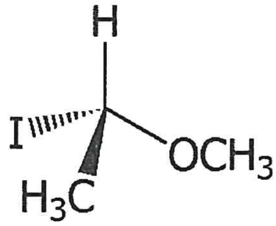
3. **(a) Arrange the order of reactivity for the following items towards S_N2 reaction. (5%)**
   1°; 2°; 3°; vinyl or aryl; methyl
   (b) Give the reasons for question 3(a). (3%)

4. **Assign (R) and (S) configurations of the following molecules. (6%)**

(a)



(b)



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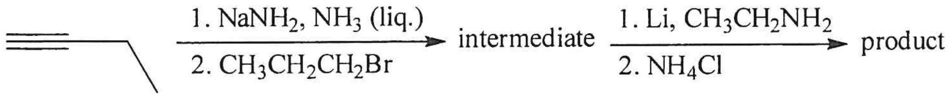
科目：有機化學

5. **Provide the reaction products and intermediates as required. (12%)**

(a)

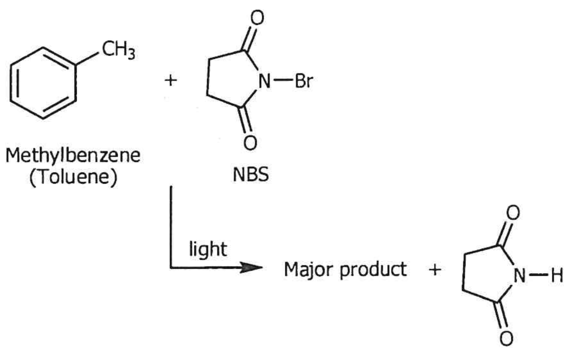


(b)

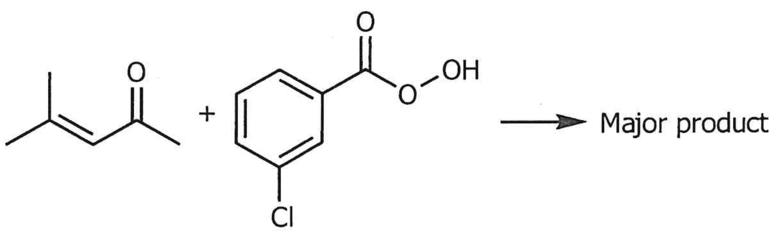
(c)

6. **What would be the major product of the following reactions? (9%)**

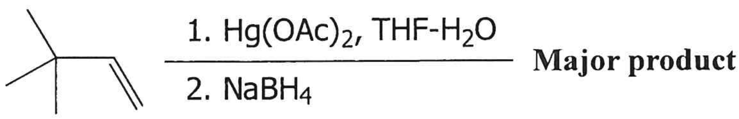
(a)



(b)



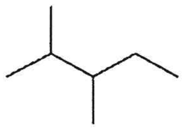
(c)



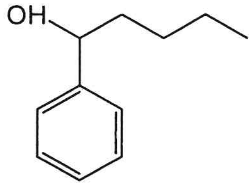
7. **Define "vicinal dihalides" and "geminal dihalides". (6%)**

8. **Give IUPAC names for the following compounds. (9%)**

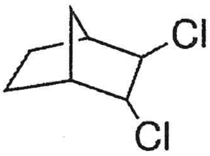
   (a)



   (b)

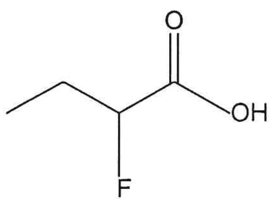


   (c)



9. **When formic acid donate a proton to be a base, the result is the formation of a formate ion ($HCOO^-$).**
   - **(a) Write two resonance structures for the formate ion, and two resonance structures for formic acid. (6%)**
   - **(b) Please identify which species, formate ion or formic acid, is most stabilized by resonance. (3%)**

10. **Which compound in each pair would be most acidic? (10%)**
    - **(a) Acetic acid; chloroacetic acid**
    - **(b)**



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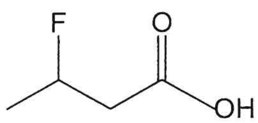

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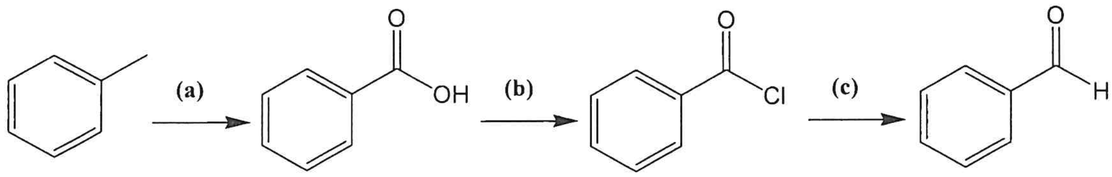
11. **Provide the reagents for transformation (a), (b) and (c). (12%)**



12. **How many ^{13}C NMR signals would you expect for acenaphthylene? (10%)**