國立雲林科技大學 110 學年度 碩士班招生考試試題

系所：化材系

科目：物理化學

1. 5.6 g of nitrogen occupies 22.8 dm^3 at 350 K. (a) Calculate the work done when the gas expands isothermally against a constant external pressure of 26.5 kPa until its volume has increased by 3.5 dm^3. (b) Calculate the work that would be done if the same expansion occurred reversibly. (16%)

2. Calculate the entropy change when 1.50 mol of gas with $C_{p,m} = 3.5R$ at 300 K and 1.50 bar is compressed to 420 K and 6.00 bar. (20%)

3. Calculate the change in the chemical potential of an ideal gas when it is expanded isothermally at a temperature of 365 K from a molar volume of 2.58 m^3 to a molar volume of 12.64 m^3. (14%)

4. It is found that the boiling point of a binary solution A and B with $x_A = 0.6218$ is 90^0C. At this temperature the vapor pressure of pure A and B are 131.2 kPa and 52.14 kPa, respectively. (a) Is this solution ideal? (8%) (b) What is the initial composition of the vapor above the solution? (7%)

5. Write the cell reaction, calculate the standard potential and estimate if it is a spontaneous cell reaction under standard condition. (10%)

$$Ag(s)|AgNO_3||CuSO_4(aq)|Cu(s)$$

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ $\quad E^{\ominus} = +0.34$ V

$Ag^{+}(aq) + e^- \rightarrow Ag(s)$ $\quad E^{\ominus} = +0.80$ V

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科目：物理化學

6. The rate constant for the first-order decomposition of N_2O_5 in the reaction $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ is $k_r = 3.38 \times 10^5\ s^{-1}$ at 25^0C. (a) What will be the pressure, initially 500 Torr, after 50 s after initiation of reaction? (10%) (b) What is the half-life of N_2O_5? (5%)

7. Suppose that there is a temperature difference of 10 K between two metal plates that are separated by 1.0 cm in air (for which $\kappa = 24.1\ mW\ K^{-1}\ m^{-1}$). What is the rate of energy transfer through an area of the opposite walls of 1.0 cm^2 in 1 h? (10%)

國立雲林科技大學 110 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. Please explain the following terms: (12%)
   (a) Newtonian fluid and Non-Newtonian fluid (4%)
   (b) Boundary conditions and Boundary layer thickness (4%)
   (c) Friction drag and Friction loss factors (4%)
2. An oil is flowing down a vertical wall as a film 2mm thick. The oil density is 800 kg/m^3 and the viscosity is 0.2 Pa·s . Calculate the mass flow rate per unit width of wall , Q , needed and the Reynolds number . Also calculate the average velocity . (18%)
3. A small capillary with an inside diameter of 2.5 x 10^{-3} m and a length 0.3 m is being used to continuously measure the flow rate of a liquid . The liquid density is 870 kg / m^3 and the viscosity is 1.2 x 10^{-3} Pa·s . The pressure-drop reading across the capillary during flow is 0.0655 m water head(density = 996 kg / m^3) . What is the volumetric flow rate of the liquid if end-effect corrections are neglected ? (20%)

國立雲林科技大學 110 學年度 碩士班招生考試試題

系所：化材系

科目：化工動力學

1. A single reactant A is converted into products by an irreversible reaction with initial concentration C_{A0}.
   (a) Please derive half-life time $t_{1/2}$ as one-half of reactant A disappears, according to zero-order rate equation of A (10 分)
   (b) Please derive half-life time $t_{1/2}$, according to first-order rate equation of A (10 分)
   (c) Based on above equations, please provide a method to determine the rate equation of A to be zero-order or first-order. (5 分)

2. For a first-order elementary reversible reaction ($A \leftrightarrow B$), k_1 is the forward rate constant and k_2 is the reverse rate constant. K is the equilibrium constant, which is equivalent to $(C_B)eq/(C_A)eq$, wherein $(C_B)eq$ and $(C_A)eq$ represent concentrations of B and A at equilibrium state.
   (a) Please derive equation $[-d\ C_A/dt]$ in terms of C_A, k_1, k_2, C_{A0} and C_{B0}. C_{A0} and C_{B0} are initial concentrations of A and B respectively. (10 分)
   (b) Please derive K in terms of C_{A0}, C_{B0} and $(C_A)eq$. (5 分)
   (c) Please solve C_A in terms of C_{A0}, $(C_A)eq$, k_2, K and t. (10 分)

3. (a) What is the chemical identity of a chemical species and its relationship to chemical reaction? (5 分)
   (b) For a second-order reaction, if a large continuous stirred-tank reactor (CSTR, volume = 10 m^3) is replaced with two small CSTRs (volume = 5 m^3) connected in series, what will happen to the overall conversion rate? Please answer with proper explanation. (5 分)
   (c) For the following plot of concentration vs time (fig. 1), please suggest the possible reaction mechanism and the reaction system with explanations. (5 分)

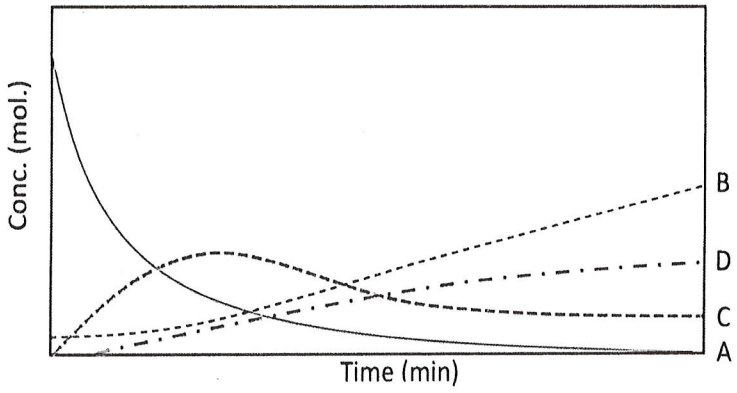


Fig. 1

國立雲林科技大學 110 學年度 碩士班招生考試試題

系所：化材系

科目：化工動力學

4. A liquid phase reaction, A+ 2B → C + D, is carried in a CSTR and is first order in both A and B with k = 0.001 $dm^3/mol \cdot min$ at 300K with activation energy E = 19870 cal/mol. The feeding molar ratio between A and B is 1:2 with an overall molar flow rate of 150 mol/min. The feeding volumetric flow rate of A and B are 50 dm^3/min and 100 dm^3/min, respectively. If the reaction temperature can be elevated to 500K, what is the required volume of CSTR to achieve 90% conversion? (Hint: gas constant = 1.987 $cal \cdot K^{-1} \cdot mol^{-1}$) (20 分)

5. The following elementary liquid phase reactions are to be carried out, and species C is the desired product

$$A \longrightarrow B \qquad r_B = k_B C_A^2$$

$$A + B \longrightarrow 2C \qquad r_C = k_C C_A C_B$$

(a) What is the instantaneous selectivity of C to B? (5 分)

(b) What kind of reactor or combination of reactors and at what temperatures would you use for this reaction system? Please answer with explanations. (10 分)

國立雲林科技大學 110 學年度 碩士班招生考試試題

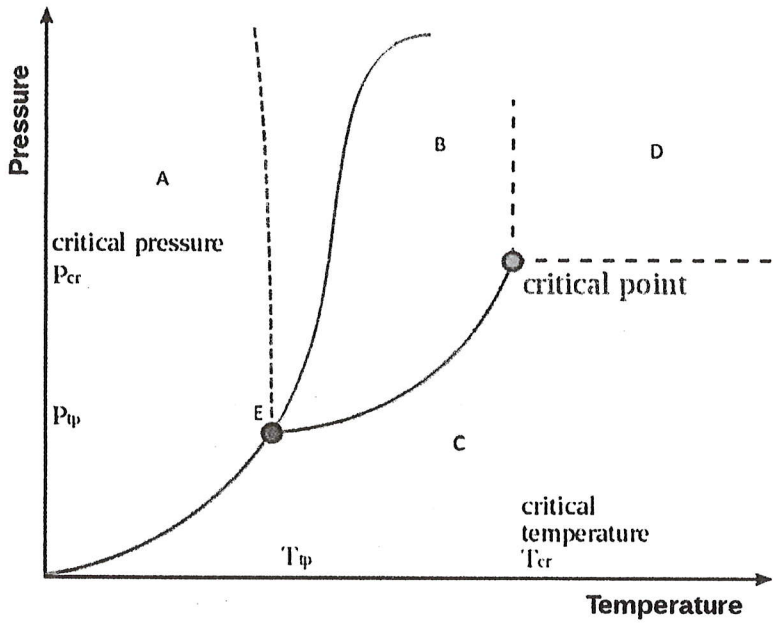
系所：化材系

科目：化工熱力學

Problem #1 (15%)

Definition:

1) Second law of thermodynamics
2) Reversible processes
3) Residual properties
4) Phase rule
5) Explain A, B, C, D, and E from the below figure.



Problem #2 (15%)

Please derivate $\eta = 1 - \frac{T_c}{T_H}$ by Carnot's theorem. T_c and T_H represent the cold and hot temperatures.

Problem #3 (20%)

An inventor has devised a complicated nonflow process in which 1 mol of air is the working fluid. The net effects if the process are claimed to be:

1. A change in state of the air from 280 °C and 3 bar to 50 °C and 1 bar.
2. The production of 2200 J of work.
3. The transfer of an undisclosed amount of heat to a heat reservoir at 30 °C.

Determine whether the claimed performance of the process is consistent with the second law. Assume that air is an ideal gas for which $C_p = 7/2R$.

Hint: $\Delta S = Cp \ln\left(\frac{T_2}{T_1}\right) - Rln\left(\frac{P_2}{P_1}\right)$

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科目：化工熱力學

Problem #4 (15%)

(a) Please explain what physical meanings of fugacity, fugacity coefficient, and activity coefficient are, respectively? Please write their difference between pure i species and species i in solution. (b) Please show how to obtain the relationship between the standard Gibbs-energy and the equilibrium constant.

5. **Problem #5 (20%)**

For the system methanol(1)/methyl acetate(2), the following equations provide a correlation for the activity coefficient: $\ln \gamma_1 = AX_2^2$, $\ln \gamma_2 = AX_1^2$, where $A = 2.8 - 0.005T$

And, the Antoine equations provide vapor pressures:

$$ln\,P_1^{sat} = 16.59 - \frac{3643.3}{T - 33.4}, \qquad ln\,P_2^{sat} = 14.25 - \frac{2665.5.3}{T - 53.4}$$

Where T is in Kelvins and the vapor pressure are in KPa. Assume the validity of modified Raoults Law, calculate:

(a) P and y_i, for T= 50℃ and $X_1 = 0.4$

(b) P and Xi, for T= 50℃ and $y_1 = 0.4$

(c) The azeotropic pressure, and the azeotropic composition, for T = 50℃.

6. **Problem #6 (15%)**

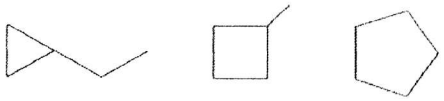
For thermodynamic property M, we can know $nM = M(T, P, n_1, n_2, ..n_i...)$, and $\overline{Mi}$ a generic partial property. Please show how to obtain $M = \sum x_i \overline{M_i}$ and $\sum x_i d\overline{M_i} = 0$ at constant T and P.

國立雲林科技大學 110 學年度 碩士班招生考試試題

系所：化材系

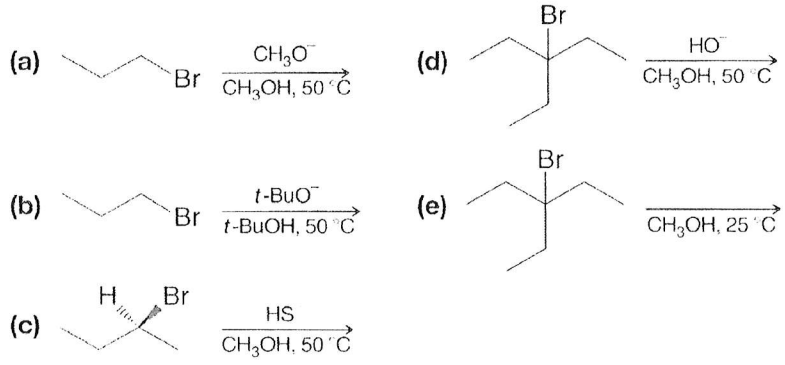
科目：有機化學

1. **Rank the following compounds in order of increasing stability based on relative ring strain. (3%)**



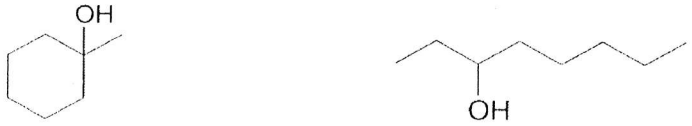
2. **Which of the following are chiral and capable of existing as enantiomers? (a) 2-butanol; (b) 1,1-dibromopropane; (c) 2-chloro-2-methylpropane; (d) 3-bromopentane; (e) 1-methyl-2-bromobicyclo[2.2.1]heptane; (f) 2-propanol; (g) 2-bromopentane; (h) 1-fluoro-2-ethylpentane. (More than one choice) (這題是複選題，答案不只一個選項) (16%)**

3. **Give the product (or products) that you would expect to be formed in each of the following reactions. In each case give the mechanism (S_N1, S_N2, E1, or E2) by which the product is formed and predict the relative amount of each (i.e., would the product be the only product, the major product, or a minor product?). (15%)**



4. **Provide the alkene needed to synthesize each of the following by hydroboration-oxidation. (10%)**

(a) **(b)**



國立雲林科技大學 110 學年度 碩士班招生考試試題

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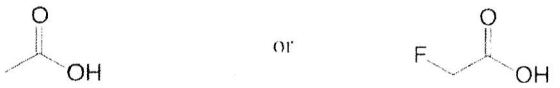
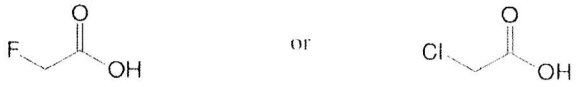
科目：有機化學

5. **Which acid of each pair shown here would you expect to be stronger? (6%)**

(a)



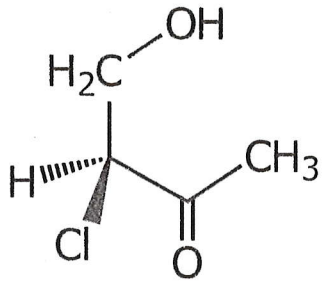
(b)



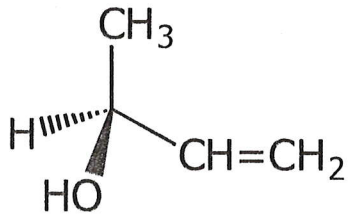
(c)

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

(a)



(b)



7. **(a) Provide the oxonium salt of the following reaction. (3%)**

(b) How to prepare pyridinium chlorochromate (PCC)? Please also provide the chemical structure of pyridinium chlorochromate (PCC) (6%)

8. **(a) Provide the chemical structures of allyl radical and vinylic radical. (6%)**

(b) Arrange the order of relative stability for the following radicals. (5%)

allylic or allyl radical; vinyl or vinylic radical; 1° radical; 2° radical; 3° radical.

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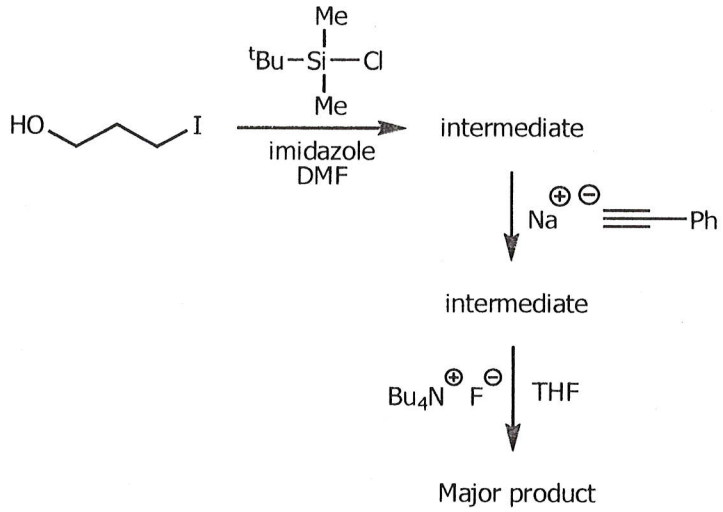
科目：有機化學

9. Provide the reaction products and intermediates as required. (15%)

(a)

(b)



10. Provide the endo and exo products of the following scheme. Which one is the major product for the shown reaction? (9%)