國立雲林科技大學 105 學年度 碩士班招生考試試題

系所：化材系

科目：物理化學

1. (a) For a monatomic perfect gas, $U_m = U_m(0\,\mathrm{K}) + (3/2)RT$ find its $C_{V,m}$. $\left(R = 8.314\,\mathrm{J\,K^{-1}\,mol^{-1}}\right)$ (8%)

   (b) For adiabatic and reversible expansion of a perfect gas, show that $T_f = T_i\left(V_i / V_f\right)^{1/c}$ where $c = C_v / nR$ (15%)

   (c) One mole of He (a perfect gas) at 25 °C is allowed to expand reversibly and adiabatically from 0.5 L to 1 L. What is the work (kJ) done by the perfect gas? (15%)

2. Calculate the AgI solubility of the following reactions at 25 °C from standard potential data:

   (a) $\mathrm{Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}}$ $E^0 = 0.80\,\mathrm{V}$

   (b) $\mathrm{AgI_{(s)} + e^- \rightarrow I^-_{(aq)} + Ag_{(s)}}$ $E^0 = -0.15\,\mathrm{V}$ (12%)

3. The enthalpy of vaporization of methanol is 34.84 $\mathrm{kJ\,mol^{-1}}$ at its normal boiling point of 337.25 K. Calculate (a) the entropy of vaporization of methanol at this temperature and (b) the entropy change of the surroundings. (15%)

國立雲林科技大學 105 學年度 碩士班招生考試試題

系所：化材系

科目：物理化學

4. At 363 K, the vapour pressure of 1,2-dimethylbenzene is 20.5 kPa and that of 1,3-dimethylbenzene is 18.5 kPa. What is the composition of a liquid mixture that boils at 363 K when the pressure is 19.6 kPa? What is the composition of the vapour produced? (15%)

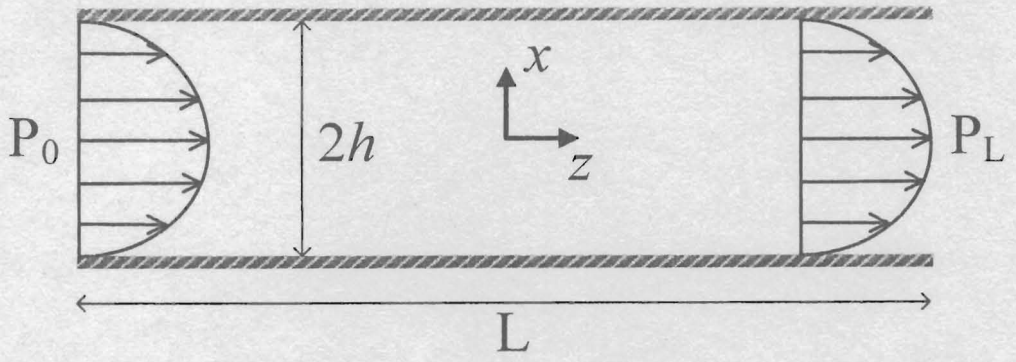
5. The rate constant for the decomposition of a certain substance is $4.00\times10^{-3}\ dm^3\ mol^{-1}\ s^{-1}$ at 308 K and $2.65\times10^{-2}\ dm^3\ mol^{-1}\ s^{-1}$ at 323 K. Determine the energy of activation and the pre-exponential factor for the reaction. (20%)

國立雲林科技大學 105 學年度 碩士班招生考試試題

系所：化材系

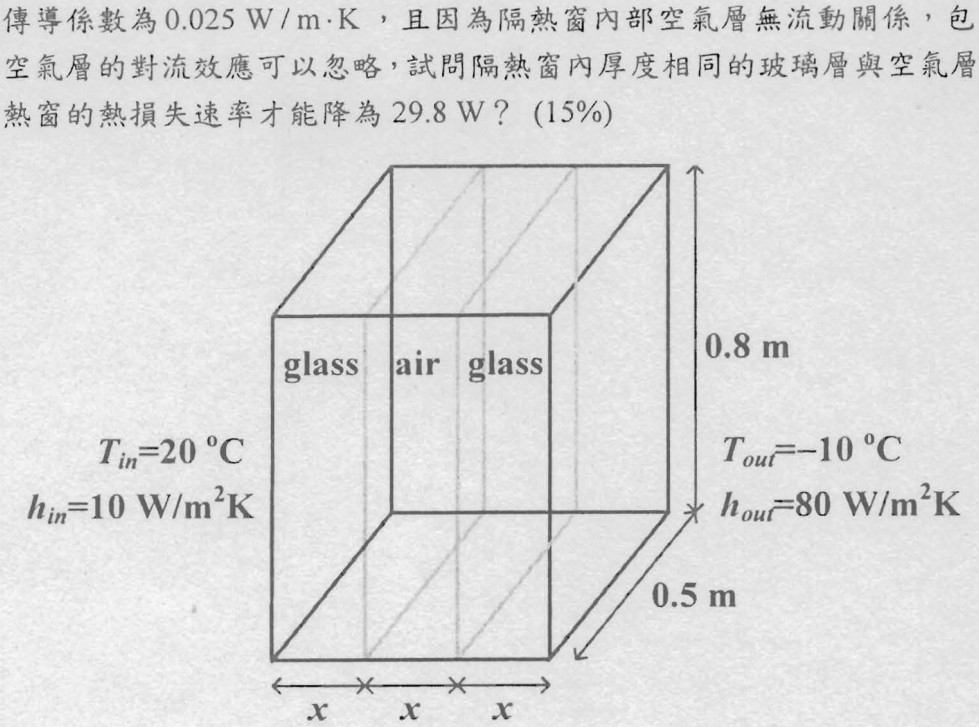
科目：單元操作與輸送現象

1. 參考下圖一，考慮一外加壓力場驅動下，兩平行平板間不可壓縮牛頓流體的運動，假設流體於兩平板間為完全展開流動，進出口效應可以忽略，座標中心位於兩平行平板中間下，試問系統內何處的(x=?)流速為系統之平均流速？ (15%)



圖一

2. 北美地區，家家戶戶常裝設隔熱窗來防止屋內熱量散失，進而禦寒，假設隔熱窗長為 0.8 公尺，寬為 0.5 公尺，其結構為兩片厚度相同的玻璃，包覆著與玻璃厚度相同的空氣層(參考下圖二)，此時隔熱窗外溫度為 −10 °C，且窗外空氣的對流熱傳係數(convective heat transfer coefficient)為 80 W / m^{2}K，反之，隔熱窗屋內溫度為 20 °C，且屋內對流熱傳係數為 10 W / m^{2}K，假設隔熱窗組成中玻璃熱傳導係數(thermal conductivity)為 1.4 W / m·K，空氣層熱傳導係數為 0.025 W / m·K，且因為隔熱窗內部空氣層無流動關係，包圍在內部玻璃層與空氣層的對流效應可以忽略，試問隔熱窗內厚度相同的玻璃層與空氣層應為多少公尺，隔熱窗的熱損失速率才能降為 29.8 W？ (15%)



圖二

國立雲林科技大學 105 學年度 碩士班招生考試試題

系所：化材系

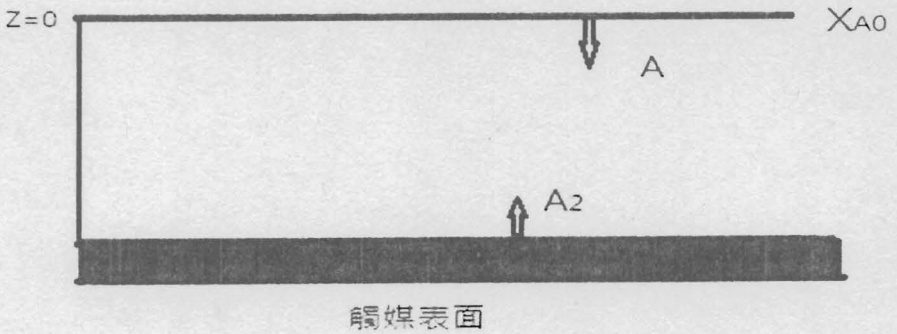
科目：單元操作與輸送現象

3. 試證明一半徑為 R，熱傳導係數為 k 的恆溫圓球，沉浸於一無限大且靜止不動的流體中，此系統的努賽數(Nusselt number)為 2。假設球體表面一直維持於固定溫度 T_R，無限遠處流體的溫度為 T_0，固液界面的對流熱傳係數為 h。 (15%)

4. 試回答下列問題：
   (a) 連續方程式的物理含意。(3%)
   (b) 推倒 Navier-Stokes 方程式的主要假設。(4%)
   (c) 雷偌數(Reynolds number)定義以及物理含意。(4%)
   (d) 畢歐數(Biot number)的定義以及物理含意。(4%)

5. 將苯及異戊烷置於密閉容器加以混合，其條件為 1.5 atm 及 110°F，兩者皆遵守勞特定律(Raoults law)，請計算混合液體及氣體各成份之組成。(110°F 下，苯之飽和蒸氣壓為 212 mmHg；異戊烷之飽和蒸氣壓為 1273 mmHg；1 atm = 760 mmHg) (20%)

6. 氣體 A 流經過一個觸媒反應器，以 $2A \rightarrow A_2$ 進行化學反應。假設觸媒表面存在一靜止薄層(厚度為δ)，成份 A 從氣相中經由薄層擴散至觸媒表面，而進行化學反應，此薄層可視為一平面(如下圖三所示)，成份 A 以 2 莫耳往正 Z 方向擴散，而成份 A_2 以 1 莫耳往負 Z 方向擴散。若氣體 A 於觸媒表面反應迅速(即氣體 A 之濃度幾乎為零)，請推導氣體 A 於薄層表面之莫耳通量，並以氣體擴散係數、薄層厚度、氣體 A 之薄層表面成份組成加以表示。(20%)



圖三

國立雲林科技大學 105 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. (15%)

Please write the mole balance equation for dimethyl ether in terms of the reaction volume and concentration within a batch reactor, a continuous-stirred tank reactor, and a tubular reactor, respectively, as the gas phase decomposition of dimethyl ether to form methane, hydrogen, and carbon monoxide is a first-order reaction.

2. (15%)

Please show the design equation, i.e. reactor volume, in terms of the conversion for a batch reactor, a continuous-stirred tank reactor, and a tubular reactor, respectively, under a first-order reaction.

3. (20%)

For a chemical vapor deposition process in which condensation occurs, e.q.,

$G(g) + A(g) \rightarrow GA\ (g,l)$

The reaction is first order in both species of G and A. The feed contains only G an A in stoichiometric amounts and the reaction is performed isothermally. The total pressure is 1 atm and GA has a vapor pressure 20.26 kPa at 300 K. Please calculate the conversion at which condensation begins and express the concentration of reaction species and the rate of reaction as a function of conversion.

4. (25%)

The elementary isomerization

$$A \longrightarrow B$$

is carried out at 350K in a CSTR with $F_{A0} = 5$ mol/min and $C_{A0} = 0.5$ mol/dm^3. Pure A is fed into the reactor and the final isomerization ratio is 75%. If the activation energy is equal to 20 kcal/mole, what will the isomerization ratio be in a same volume PFR at 325 K with same feeding condition?

5. (25%)

The complex liquid phase reactions 1 and 2 follow elementary rate law. (a) Write the net formation rates of species A, B, C, and D in terms of concentration and reaction constant k_{1A} and k_{2D}. (b) If C is the desired product and D is the byproduct, write the instantaneous selectivity.

Reaction 1: $A + 3B \xrightarrow{k_{1A}} 4C$

Reaction 2: $2A + C \xrightarrow{k_{2D}} 2D$

國立雲林科技大學 105 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. (15%)

Air at 1 bar and 25°C (molar volume 0.02479 m^3 mol^{-1}) is compressed to 5 bar and 25°C by a mechanically reversible process: heating at constant volume followed by cooling at constant pressure. Assume that constant-volume heat capacity for air is (5/2)R, R = gas constant, and that PV/T is a constant for air. Calculate

(a) Heat transferred during the heating. (3%)

(b) Heat transferred during the cooling. (3%)

(c) Internal energy change during the cooling. (3%)

(d) Work for this process. (3%)

(e) Enthalpy change for this process. (3%)

2. (14%)

An inventor claims to have devised a piston/cylinder device to compress one mole of ideal gas isothermally but irreversibly at 100°C from 3 bar to 8 bar. The work required is 30% greater than the work of reversible, isothermal compression. The heat transferred from the gas during compression flows to a heat reservoir at 60°C.

(a) Calculate the entropy changes of the gas and the heat reservoir. (7%)

(b) Justify whether or not the device is thermodynamically possible, and list calculations. (7%)

3. (21%)

Steam generated in the boiler of a power plant at a pressure of 8600 kPa and a temperature of 500°C is fed to a turbine. Exhaust from the turbine enters a condenser at 10 kPa, where it is condensed to saturated liquid, which is then pumped to the boiler. Calculate

(a) The expansion work done by the turbine that operates reversibly and adiabatically, and the quality of the exhaust steam. (7%)

(b) The actual expansion work and the quality and properties of the exhaust steam, if a turbine efficiency is 75%. (7%)

(c) The thermal efficiency of a Rankine cycle operating these conditions, assuming a heat input of 3200 kJ kg^{-1} steam into the boiler and a negligible pump work. (7%)

Steam enthalpy (H) and entropy (S) data are given below.

At 8600 kPa and 500°C: H = 3391.6 kJ kg^{-1}; S = 6.6858 kJ kg^{-1} K^{-1}.

At 10 kPa: saturated vapor H = 2584.8 kJ kg^{-1}; S = 8.1511 kJ kg^{-1} K^{-1}.

saturated liquid H = 191.8 kJ kg^{-1}; S = 0.6493 kJ kg^{-1} K^{-1}.

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系所：化材系

科目：化工熱力學

4 (15%)

1-mole ideal gas (C_p = 29 J/mol K) is cooled down from 300 K and 0.1 MPa to 250 K and 5 MPa. Calculate the entropy change of the gas $\triangle S$.

5. (15%)

A gas obeys the equation of state.

$$\left(P + \frac{a}{\underline{V}^2}\right)\underline{V} = RT$$

The critical point (T_C, P_C, $\underline{V}_C$) for the gas is assumed to be determined by the following requirement:

$$\left(\frac{\partial P}{\partial \underline{V}}\right)_{T_C} = 0$$

Determine the parameter a and compressibility factor at the critical point Z_C.

6. (20%)

An ideal gas (C_v = 21 J/mol K) at 5 MPa and 300 K is filled adiabatically into a tank. If the tank initially contains gas at 0.1 MPa and 300 K, what will be the temperature of the gas in the tank when the tank is repressurized to 4 MPa?

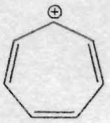
國立雲林科技大學 105 學年度 碩士班招生考試試題

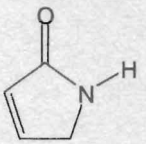
系所：化材系

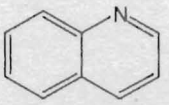
科目：有機化學

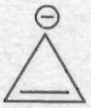
1. 請排列下列元素之電負度大小順序。(5 %)
   Br, N, O, H, C, F

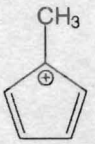
2. 請分別指出下列的分子結構是屬於aromatic、antiaromatic或nonaromatic。(18 %)

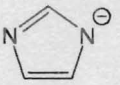
(a) 

(b) 

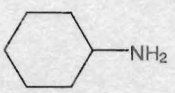
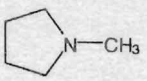
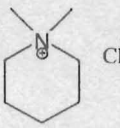
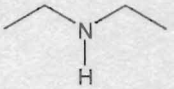
(c) 

(d) 

(e) 

(f) 

3. 下列哪一個化合物是屬於三級胺? (3 %)

(a)  ; (b)  ; (c)  ; (d) 

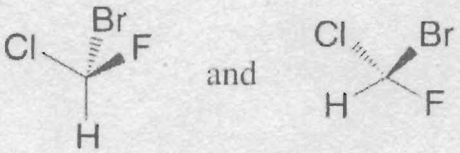
4. 當添加溴於 cis-2-butene 時，請依據 cyclic bromonium ion 畫出其反應機制並畫出其主要產物。(10 %)

5. 請畫出 4-fluoromethyl-2-nitroanisole 的化學結構。(5 %)

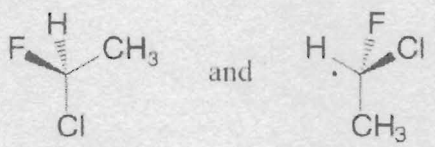
6. 有一化合物(C_8H_{10})的氫譜中有三個主要吸收峰，面積比是5:2:3，化學位移δ值分別是：(1) 7.2 ppm (單峰)、(2) 2.6 ppm (四重峰)、(3) 1.2 ppm (三重峰)，請問三個吸收峰所對應的基團各是什麼(6 %)？請畫出此化合物的結構。(3 %)

7. 請說出下列每小題中之兩結構是 enantiomers，還是相同化合物?

(a) 5%



(b) 5%



國立雲林科技大學 105 學年度 碩士班招生考試試題

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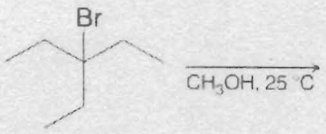
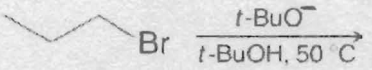
8. 下列反應中，其產物為何？如果有超過一種產物，請標示其主產物(major product)與副產物(minor product)。並請標示各產物是經由何種反應機構(S_N1，S_N2，E1 還是 E2)形成。

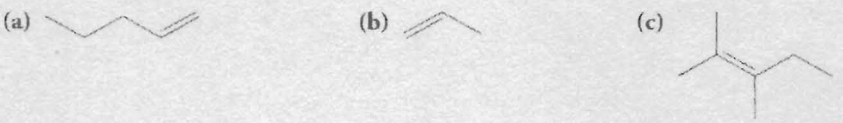
(a) 5%



(b) 5%

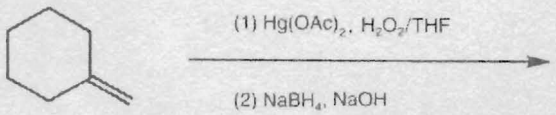


9. 下列三種 alkenes 與 HBr 反應，請依序排列反應速率最快是哪一個?最慢是哪一個? (5%)

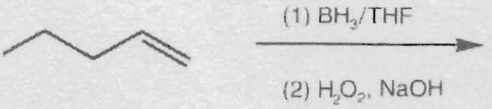


10. 預測下列反應的產物。

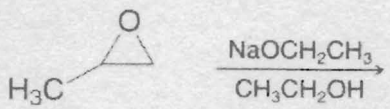
(a) 5%



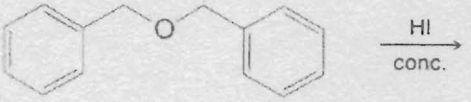
(b) 5%



(c) 5%



(d) 5%



(e) 5%