（橫書式）

國立中山大學八十七學年度碩博士班招生考試試題

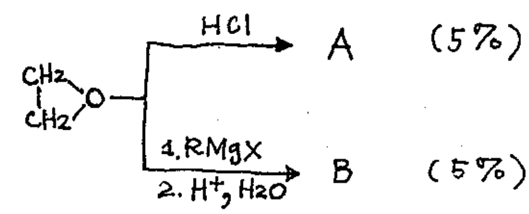
科　目：有機化學（材料科學研究所）甲組　　共 1 頁 第 1 頁

1) a) Show the two possible conformations of chlorocyclohexane? (10 %)
   b) Which of the two conformations in a) is more stable? (5 %) why? (5 %)

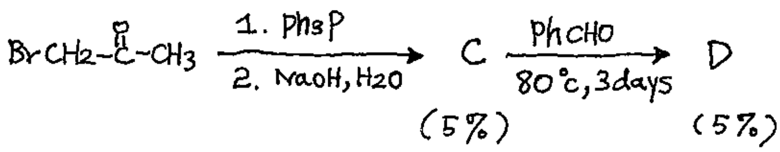
2) A substance with molecular formula $C_{10}H_{12}O_2$ gives the following information. What is its structure? (15 %)
   IR (cm^{-1}): 1670; ^{1}H NMR (δ): 1.2 triplet (3 H), 2.9 quartet (2 H), 3.9 singlet (3 H), 7.0 and 8.0 pair of doublet (4 H).

3) a) *p*-Nitrophenol is more acidic than *m*-nitrophenol, why? (10 %)
   b) Ethyne (HC≡CH) is more acidic than ethene (CH_2=CH_2), why? (15 %)

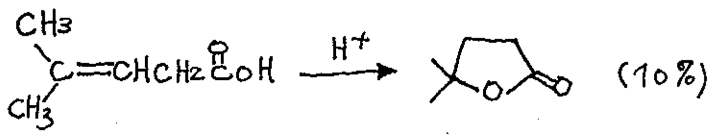
4) Write down the chemical structures of products A, B, C, and D.
   a)



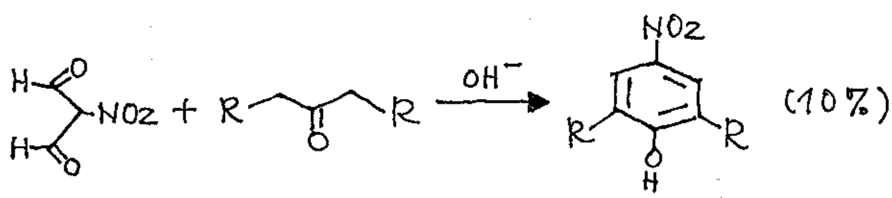
   b)



5) Write down the mechanistic pathways for the following reactions.
   a)



   b)



1. A certain n^{th} order reaction (with Arrhenius type of temperature dependence) is 20% complete in 12.0 min at 300 K and in 3.0 min at 350 K. Estimate its activation energy E_a (in Joule, accuracy within one order of magnitude). [20%]

2. What is the wavelength of a photon, having a kinetic energy of 3 eV (in nm, accuracy within ±100%)? [10%]

3. For regular solutions in which the components have molecules of the same size, the Gibbs energy of mixing is

$$\Delta G_M = RT(n_1 \ln X_1 + n_2 \ln X_2) + (n_1 + n_2) X_1 X_2 w$$

where n denotes the amount of component, X the mole fraction , and w is a parameter that measures the deviation from Raoult's Law. Show that for such solution, the chemical potentials are

$$\mu_1 = \mu_1^* + RT \ln X_1 + w(X_2)^2$$
$$\mu_2 = \mu_2^* + RT \ln X_2 + w(X_1)^2$$

where μ_1^* , μ_2^* refer to the pure liquids. Show that the activity coefficients are given by

$$\ln \gamma_1 = (X_2)^2 (w/RT)$$
$$\ln \gamma_2 = (X_1)^2 (w/RT)$$

Benzene and CCl_4 form regular solutions with w = 324 J·mole^{-1} at 298 K and dw/dT = -0.368 J·deg^{-1} . For an equimolar solution, calculate the mixing functions, ΔH_M and ΔS_M^{ex}, where ΔS_M^{ex} is the excess entropy. [40%]

4. (A). A funny scientist has synthesized a most unusual gas call wakon which follows exactly the equation of state $(P + n^2a/V^2)(V-nb) = nRT$, i.e., van der Waals' equation with $b = 0$, except that a is a function of temperature such that for $T \leq T_W$, $a = 0$, but for $T > T_W$, $a = a_0/T$, where a_0 is a constant. Derive the thermal expansivity α and the isotheraml compressibility β, as functions of P, V, T.

(B). A kilogram of ethylene (C_2H_4) is compressed from 10^{-3} m^3 to 10^{-4} m^3 at a constant temperature of 300 K. Calculate the minimum work that must be expanded, assuming that the gas is ideal. You are required to show the numerical result (in kJ, accuracy within ±100%).

(C). Repeat (B) except that the gas is van der Waals. This time, show the derivation only, no numerical data is needed.

[30%]

REFERENCE TABLES:

Table I. Natural Logarithms of Selected Numbers

ln 2.0	0.6931
ln 3.0	1.0986
ln 4.0	1.3863
ln 5.0	1.6094
ln 6.0	1.7918
ln 7.0	1.9459
ln 8.0	2.0794
ln 9.0	2.1972
ln 10.0	2.3026

Table II. Gas Law Constant R

Numerical Value	*Units*
1.9872	g cal/g mol·K
1.9872	btu/lb mol·°R
82.057	cm^3·atm/g mol·K
8314.34	J/kg mol·K
82.057×10^{-3}	m^3·atm/kg mol·K
8314.34	kg·m^2/s^2·kg mol·K
10.731	$ft^3 \cdot lb_f/in.^2$·lb mol·°R
0.7302	ft^3·atm/lb mol·°R
1545.3	ft·lb_f/lb mol·°R
8314.34	m^3·Pa/kg mol·K

國立中山大學八十七學年度碩博士班招生考試試題

科　目：工程數學（材料科學研究所）乙、丙組

1. Solve the following initial value problem.
   $y''' - y'' - y' + y = 0,\ y(0) = 2,\ y'(0) = 1,\ y''(0) = 0$

2. Use Laplace transforms to solve the following initial value problem.
   $y'' + 4y = r(t)$, r(t)=3sint if $0 < t < \pi$ and -3sint if $t > \pi$, $y(0) = 0, y'(0) = 3$

3. Find the Fourier transforms of the following function.

$$f(x) = \begin{cases} -1 & \text{if } -1 < x < 0 \\ 1 & \text{if } 0 < x < 1 \\ 0 & \text{otherwise} \end{cases}$$

4. Find the work done by the force **P** = 4xy**i** - 6y**j** + 2**k** in the displacement: counterclockwise around the circle $x^2 + y^2 = 4$, z=0.

5. Using polar coordinates, evaluate $\iint_R f(x, y)\,dxdy$, where $f = e^{-x^2-y^2}$,
   R: the annulus bounded by $x^2 + y^2 = 1$ and $x^2 + y^2 = 4$.

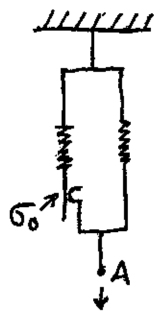
（共五題，每題20分）

國立中山大學八十七學年度碩博士班招生考試試題

科　目：材料力學(材料所乙組)　　　　共 1 頁 第 1 頁

1. To solve a carck problem, one is given a complex potential function Φ, where $\Phi=\sigma_0 z/(z^2-a^2)^{1/2}$, $z = x + iy$, and $\sigma_{yy} = \mathrm{Re}\Phi + y\mathrm{Im}\Phi'$, a is carck length
   (A) Please find an analytical solution of σ_{yy} along x axis.**(10%)**
   (B) If let $r = (z-a)e^{i\theta}$, Please find a general soution of σ_{yy} in terms of r and θ.**(20%)**

2. You are given two identical springs with the same length and elastic constant, ℓ and k, respectively. These two springs and a friction glider are arranged as following. The friction force is σ_0.
   (A) Please calculate and draw the loading curve (Load, P vs. elongation, Δ) at point A, while point A is loaded upto $1.3\sigma_0$. **(20%)**,
   (B) and then, point A is unloaded. **(10%)**.



3. In a known stress field, only σ_{xx}, τ_{xy}, τ_{yz} exist, where $\tau_{xy} = S\cos\theta$, $\tau_{yz} = S\sin\theta$, $\sigma_{xx} = S$. Please find the principal stress. **(20%)**
4. If Maximum shear theory is the yeild criteria, and a material has its tensile yield stress, σ_0=100ksi, please find what σ_x is needed to yeild the material with $\sigma_y=\sigma_z$=50ksi. **(10%)**
5. In a body we find σ_{xx}=50ksi, σ_{yy}=40ksi and τ_{xy}=20ksi, please find $\sigma_{x'x'} + \sigma_{y'y'}$ after x and y rotate 30 degree clockwise to new axes x' and y'. **(10%)**

國立中山大學八十七學年度碩博士班招生考試試題

科　目：熱力學（材料科學研究所丙組）　　　　共 1 頁 第 1 頁

1. The heat capacity under constant pressure (C_p) is 1 cal/g °C for water and 0.5 cal/g °C for ice. The heat of fusion of ice is 80 cal/g. For the case of the freezing of 1 kg supercooled water at –10°C,
   (a) how much heat is released?
   (b) What is the entropy change of the system?
   (c) What is the entropy change of the universe? (25%)

2. Derive the equation

$$dU = (C_p - PV\alpha)\, dT + V(P\beta - T\alpha)dP$$

   where U is the internal energy and α and β are the coefficients of thermal expansion and compressibility, respectively. (25%)

3. One mole of an ideal gas, initially at 273 K and one atmosphere, is contained in a chamber that permits programmed control of its state. Controlled quantities of heat and work are supplied to that system so that its pressure and volume change along a line given by the equation

$$V = 22.4 \text{ (liter/atm) } P.$$

   Assume the process is carried out reversibly.
   (a) What is the heat required to be supplied to the system to take it to a final pressure of 0.5 atm.
   (b) What is the final temperature of the gas?
   (c) What is the final volume of the gas? (25%)

4. For an ideal gas of initial state P_i and V_i to perform reversible isothermal and adiabatic expansion to the same final volume of V_f,
   (a) calculate the work done in each case. Which one is larger? Why?
   (b) What is the final temperature of each process?
   (c) Discuss each process with the first law of thermodynamics. (25%)