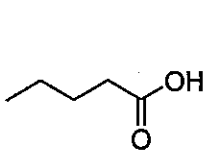
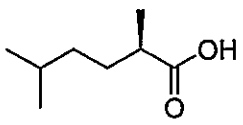
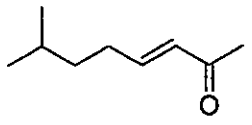
有機部份 （50 分）

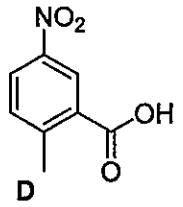
第一題 寫出下列化合物 IUPAC 名稱。(各 2 分, 共 8 分)

Problem 1 Give IUPAC name for the following compounds. (8 pts)


A


B

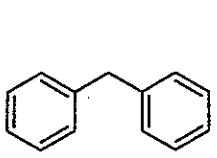

C

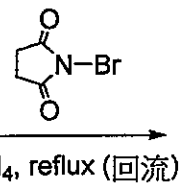

D

第二題 寫出下列化合物結構式。(共 24 分)

Problem 2 Predict the products of the following reactions. (24 pts)

(a)





CCl_4, reflux (回流)

Compound **E** (化合物 **E** 1 分)

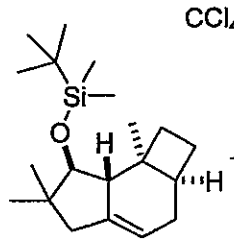
$2\ Br_2$

CCl_4, light (光照)

Compound **F** (化合物 **F** 1 分)

C^{13} NMR: δ 69.20 145.15 127.80, 128.39 128.78

(b)

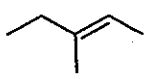


BH_3

H_2O_2, OH^-

Compound **G** (化合物 **G** 2 分)

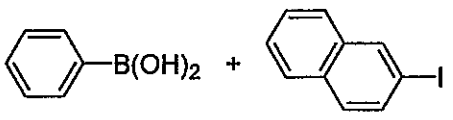
(c)



Br_2

Compound **H** (化合物 **H** 2 分)

(d)



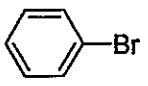
$Pd(PPh_3)_4$

K_2CO_3

Cu salt

Compound **I** (化合物 **I** 2 分)

(e)

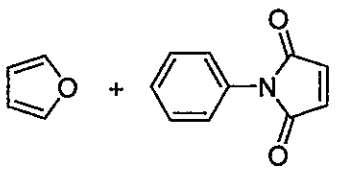


Mg

Compound **J** (化合物 **J** 1 分)

Compound **K** (化合物 **K** 1 分)

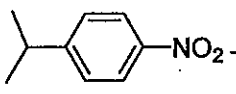
(f)



heat (加熱)

Compound **L** (化合物 **L** 2 分)

(g)



Fe

HCl

Compound **M** (化合物 **M** 2 分)

$NaNO_2$

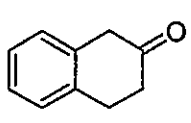
HCl

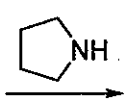
Compound **N** (化合物 **N** 2 分)

CuCN

Compound **O** (化合物 **O** 2 分)

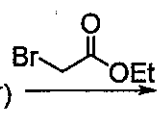
(h)





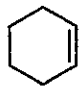
H^+ (cat)

Compound **P** (化合物 **P** 2 分)



Compound **Q** (化合物 **Q** 2 分)

(i)



CH_2I_2

Zn-Cu

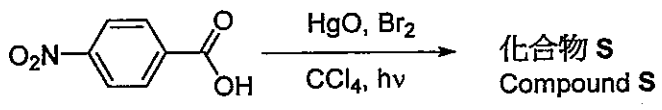
Compound **R** (化合物 **R** 2 分)

見背面

第三題 (共 8 分)

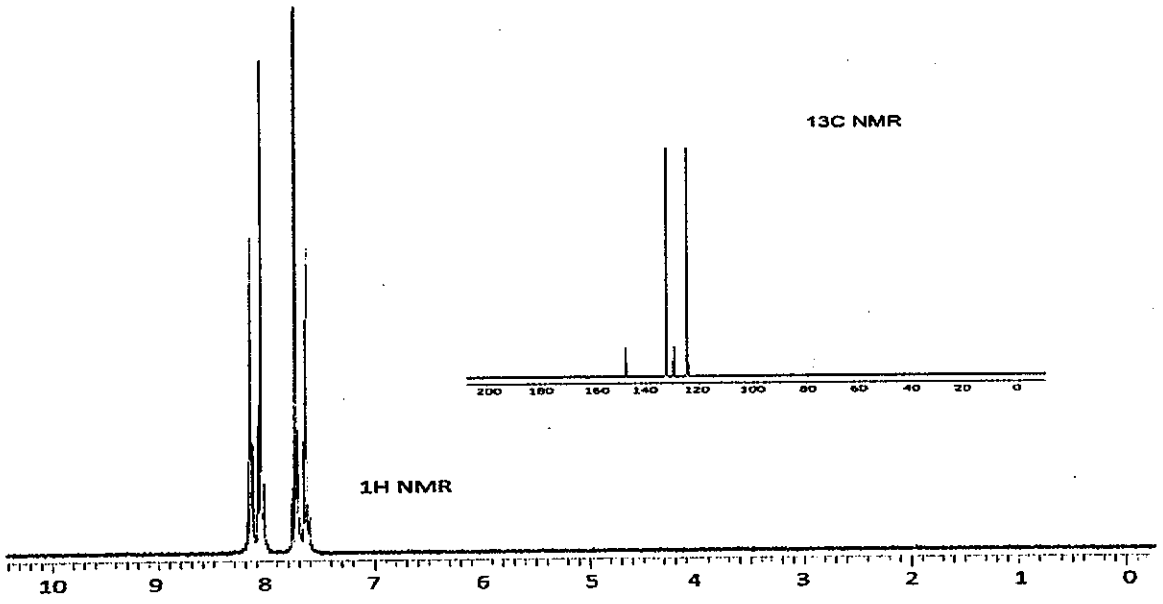
Problem 3 (8 pts)

(a) 寫出化合物 **S** 結構式。 (2 分). What is the structural formula of **S**? (2 pts)

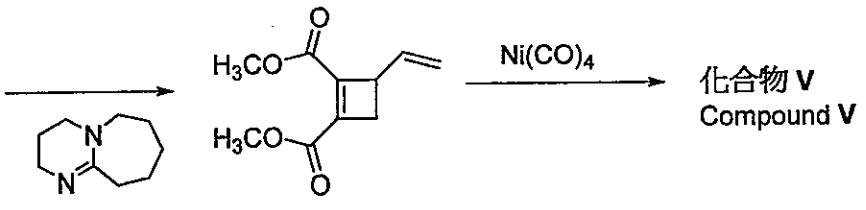


Molecular weight of **S**（**S** 的分子量）: 202.005;

^{1}H NMR and ^{13}C NMR (inset) spectra are shown as follows （下圖為 **S** 的 ^{1}H NMR 和 ^{13}C NMR (插圖) ）



(b) 寫出化合物 **T, U, V** 結構式。(各 2 分) Predict the chemical structures of **T** (2 pts), **U** (2 pts), and **V** (2 pts).



化合物 **V** 分子式 為 $C_{10}H_{12}O_4$，其 NMR 與 IR 光譜如下:

Compound V, with a molecular formula of $C_{10}H_{12}O_4$, shows the following spectral data

^{1}H NMR (400 MHz, $CDCl_3$) δ 5.71 (s, 2H), 3.78 (s, 6H), 3.0 (s, 4H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 168.5, 132.5, 122.4, 52.2, 27.5;

IR (cm^{-1}) 3038, 2998, 2952, 2884, 2843, 2827, 1724, 1681, 1644, 1434, 1256, 1063.

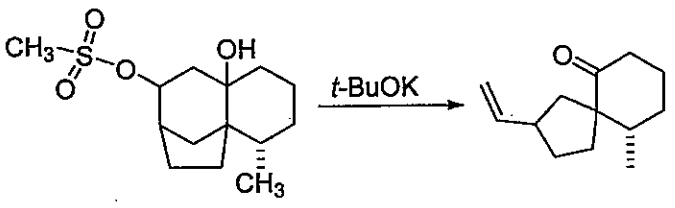
第四題 環已烯，1,3-環已二烯，與苯的氫化熱分別為 28.6 kcal/mol, 55.4 kcal/與 49.8 kcal/mol。按上述數據，估算苯的芳香穩定共振能，並提出說明。 (2 分)

Problem 4 The heats of hydrogenation of cyclohexene, 1,3-cyclohexadiene, and benzene are 28.6 kcal/mol, 55.4 kcal/mol, and 49.8 kcal/mol respectively. On the basis of these data, estimate the aromatic stabilization energy (the resonance energy) of benzene. Give explanations to support your estimation. (2 pts)

接次頁

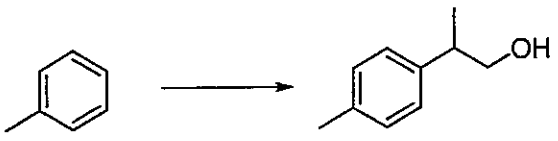
第五題 寫出下列反應之機構。 (3 分)

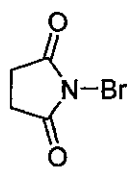
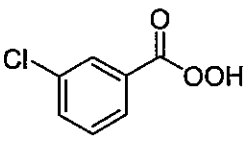
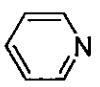
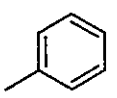
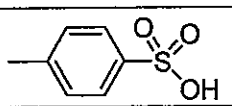
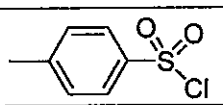
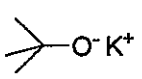
Problem 5 Propose reaction mechanisms for the following transformation. (3 pts)



第六題 提出下圖的合成策略，試劑庫中的試劑，或其他少於三碳（含）有機試劑均可使用。 (5 分)

Problem 6 How could you carry out the following transformation? Either the reagents listed in the following reagent tool box or reagents less than 3 carbons can be used. (5 pts)



Reagent tool box（試劑庫）			
			
$KHSO_4$		H_2O_2	
$CHCl_3$			H-C≡C-H
Fe	Ni	NH_3	$NaNH_2$
Li	Na	Mg	K
$NaBH_4$	BH_3	PBr_3	Br_2
$SOCl_2$	HCl	Pd/C, H_2	F
	NaOH	$CH_3-O^- K^+$	OsO_4
$HgSO_4$	CH_2I_2, Zn/Cu	$NaIO_4$	O_3/ Ma_2S

見背面

無機部份 （共 50 分）

第 1～5 題：多重選擇題，每題 4 分（錯一個選項 2 分，錯兩個選項 0 分），請依題號順序於『選擇題作答區』內作答。

1. Which of the following description of metallic and ionic solid is/are correct?
   a. The packing density of simple cubic is lower than that of diamond structure.
   b. In an interstitial alloy, the atomic radii difference between guest element and host element should be less than 15%.
   c. The calculated lattice enthalpy of LiF using Born-Mayer equation is expected to differ substantially from the experimental value obtained from Born-Haber cycle.
   d. The non-stoichiometric Fe_2O_{3-x} oxide is an n-type semiconductor.
   e. None of the above.

2. Which of the following description of acids is/are correct?
   a. HNO_3 and HSO_3F behave as bases in liquid H_2SO_4.
   b. $HClO_4$ (pK_a = -10) is more acidic than HCl (pK_a = -8) in water.
   c. Acetic acid (pK_{ion} =14.5) is a better solvent than water (pK_{ion} =14) in determining the acidity difference of acids.
   d. The *pH* value of water at higher temperature is smaller.
   e. None of the above.

3. Which of the following description of chemical bonds is/are correct?
   a. M-M π-bond for heavier metal is always weaker than that of the lighter metals in the same group.
   b. C-O single bond is stronger than Si-O single bond due to the better overlap between 2p orbitals.
   c. The M-C bond in $[V(CO)_6]^-$ is stronger than that in $[Mn(CO)_6]^+$.
   d. There is M-M single bond in $Re_2(CO)_{10}$ and $Fe_2(CO)_9$.
   e. None of the above.

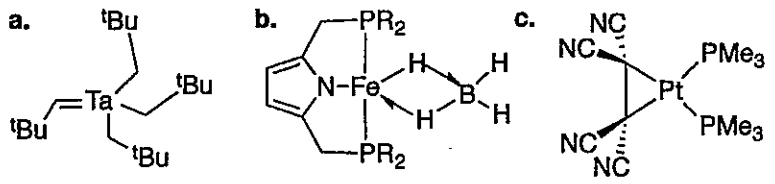
4. Which of the following description of a $[NiL_6]^{2+}$ complex is/are correct?
   a. The ground state term of the complex is $^3T_{1g}$
   b. The Δ_O can be estimated from the lowest d-d transition band.
   c. The absorption bands of $[Ni(H_2O)_6]^{2+}$ are lower in energy compared to that of $[Ni(en)_3]^{2+}$.
   d. If the central metal ion is replaced by Pt^{2+}, all absorption bands will be red-shifted.
   e. None of the above.

5. Which of the following description of organometallic complexes is/are correct?
   a. The associative ligand substitution of $[NiL_4]$ (L = $P(OEt)_3$) can be promoted by changing the L from $P(OEt)_3$ to $P(O^iPr)_3$.
   b. A *cis* orientation of eliminating ligand is required for concerted reductive elimination.
   c. Reductive elimination of ligands can be promoted by oxidation of the metal center.
   d. For an 18-electron L_nM-Bn complex (Bn = benzyl), dissociation of a *cis*-ligand is required for β-hydride elimination.
   e. None of the above.

接次頁

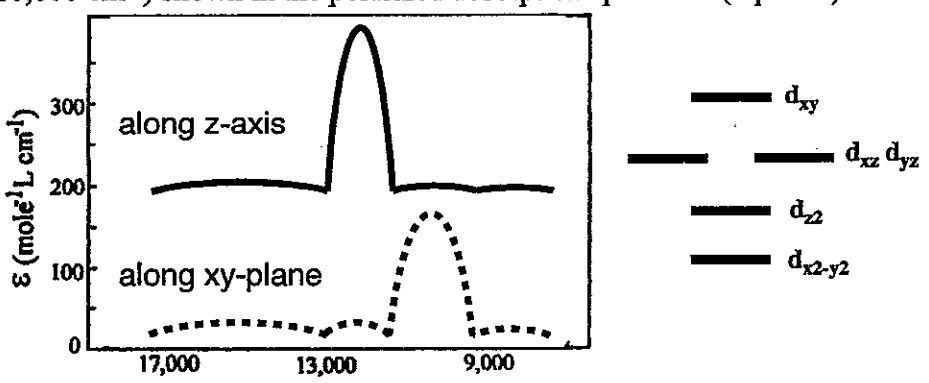
第 6～8 題問答題，請依題號順序於『非選擇題作答區』內作答，並應註明作答之部份及題號。

6. Please give the **d^n configuration of the central metal ion** and the **total electron count of the metal complex**. (12 points)



7. Please answer the following questions about a $C_4B_2H_6$ molecule:
   a. Classify the compound according to Wade's rule. Justify your answer (4 points)
   b. Structure of all isomers and their corresponding symmetry point group. (6 points)

8. It is known that a tetra-coordinate Cu^{2+} complex adopts D_{2d} geometry in solid state. With the given d-orbital splitting, please assign the transition bands (12,000 cm^{-1} and 10,000 cm^{-1}) shown in the polarized absorption spectrum. (8 points)



$D_{2d} = V_d$ $(\overline{42})m$	E	$2S_4$	C_2	$2C_2'$	$2\sigma_d$		
A_1	1	1	1	1	1		x^2+y^2, z^2
A_2	1	1	1	−1	−1	R_z	
B_1	1	−1	1	1	−1		x^2-y^2
B_2	1	−1	1	−1	1	z	xy
E	2	0	−2	0	0	(x, y) (R_x, R_y)	(xz, yz)

試題隨卷繳回