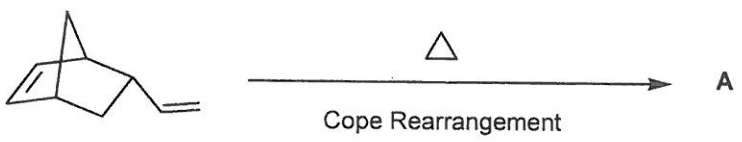
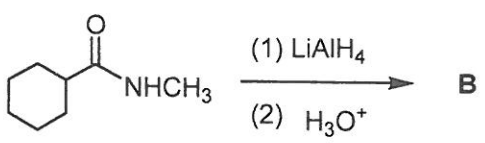
有機化學（總分50分）

I. (3 points each) Predict the major product of the following reactions:

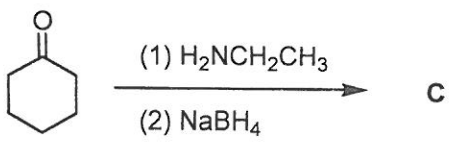
(a)



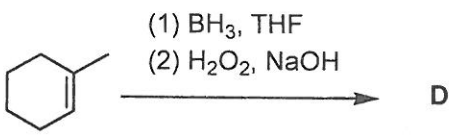
(b)



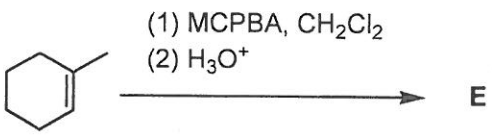
(c)



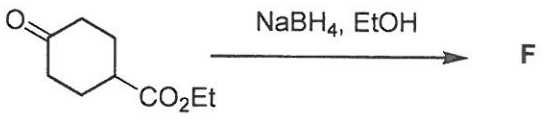
(d)



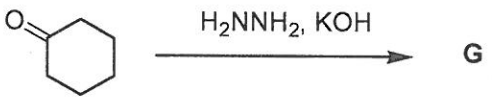
(e)



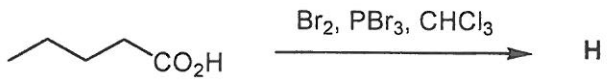
(f)



(g)

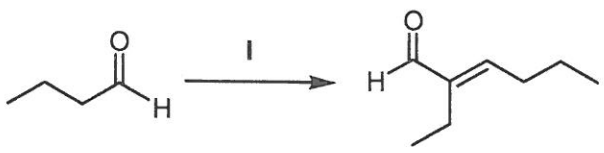


(h)

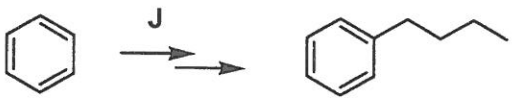


II. (3 points each) Suggest a reagent (or reagents for stepwise reactions) that can be used to accomplish the following transformation:

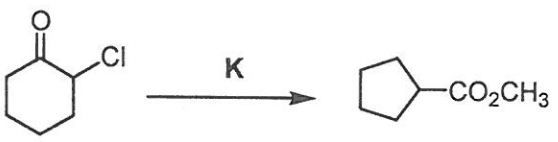
(a)



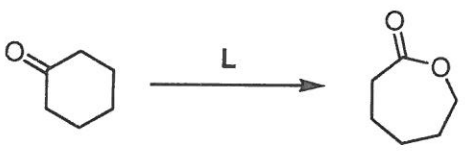
(b)



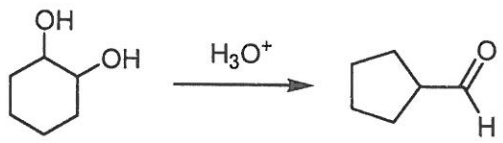
(c)



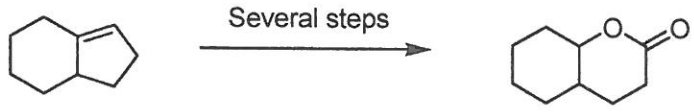
(d)



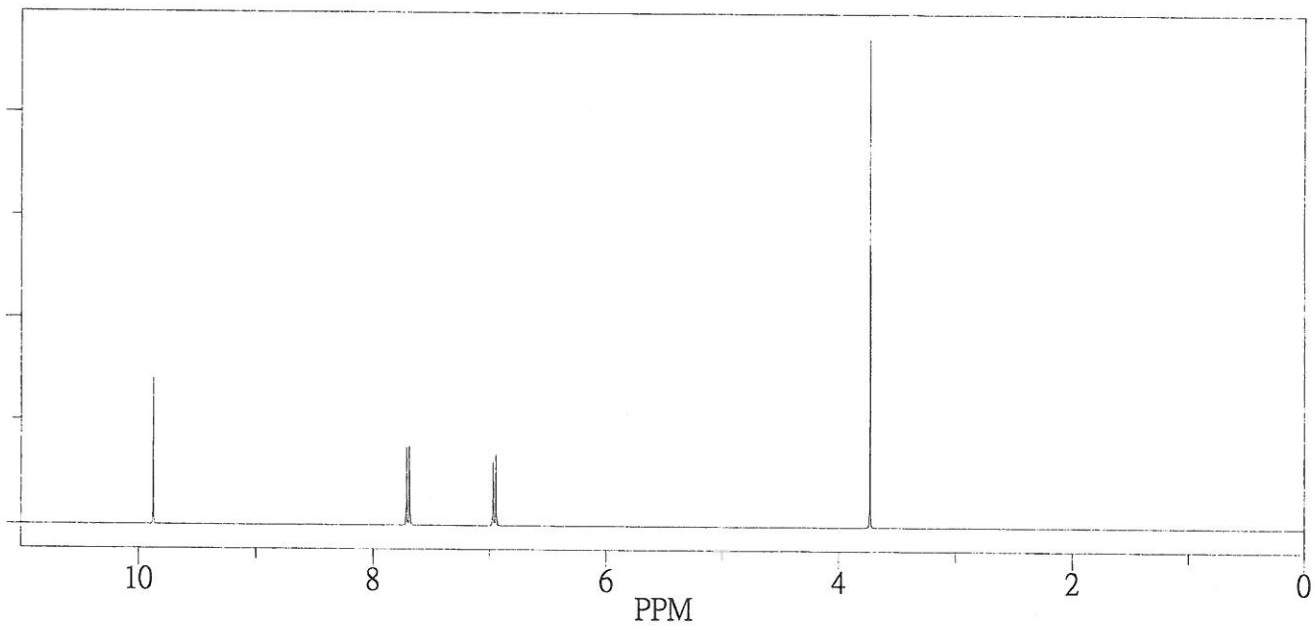
III. (4 points) In the transformation illustrated below, write out a reasonable mechanism which account for the transformation.

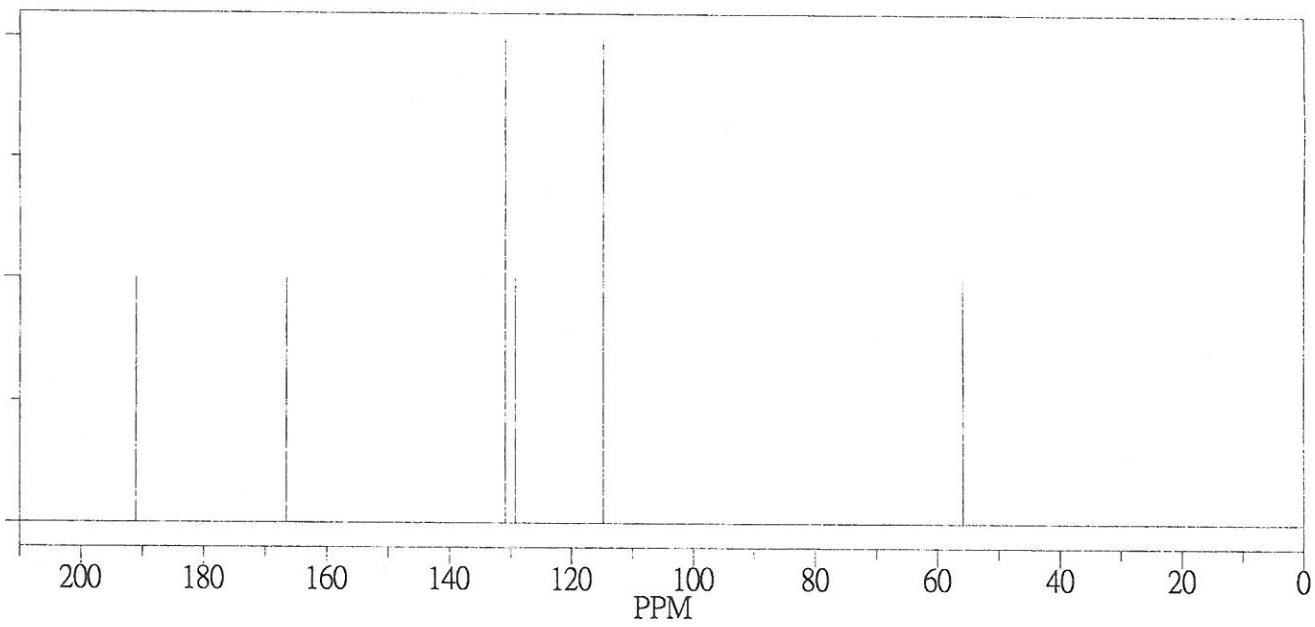


IV. (5 points) Please propose the necessary reactions and reagents to carry out the synthesis of the following target molecule.



V. (5 points) Deduce the structure of the following compound ($C_8H_8O_2$);
^{1}H NMR integration 1:2:2:3





(ppm rel. to TMS)

191.0
166.5
130.9
129.2
114.8
55.9

科目：無機化學

共21題，1-18題每題2分，19、20題每題4分，21題6分，合計50分。
第1-19題只需寫出答案，20及21題需列出詳細推演。

Arrange each of the followings (questions 1~8) in the order of increasing trend.

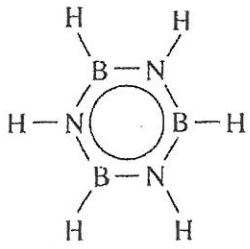
1. Ionization energy: Cl, Cl^-, Cl^+
2. Ionic radius: Y^{3+}, Zr^{4+}, Nb^{5+}
3. Bond angle (∠HXH): NH_3, PH_3, AsH_3
4. Brønsted basicity : NH_3, PH_3, AsH_3
5. Acid strength in aqueous solution: HClO, $HClO_2$, $HClO_4$
6. Band gap: C (diamond), Si, Ge
7. Number of unpaired electrons: $[Fe(CN)_6]^{4-}$, $[Fe(CN)_6]^{3-}$, $[FeCl_6]^{4-}$
8. C—O stretching frequency: $[Re(CO)_6]^+$, $[W(CO)_6]$, $[Ta(CO)_6]^-$

Determine the ground terms for the configurations in questions 9 and 10.

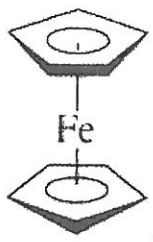
9. low-spin d^5 (O_h symmetry)
10. d^4 (T_d symmetry)

Determine the point group for each of the molecules in questions 11~13.

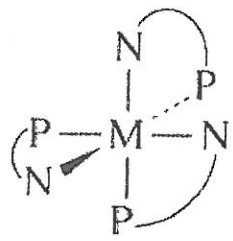
11. Borazine



12. Staggered Ferrocene



13. $M(NH_2CH_2CH_2PH_2)_3$
(consider the $NH_2CH_2CH_2PH_2$ rings as planar)



Predict the products of the reactions in questions 14~16.

14. $V(CO)_6 + NO \longrightarrow$

15. $(\eta^5\text{-}C_5Me_5)Rh(CO)_2 \xrightarrow{h\upsilon}$ (dimeric product, contains one CO per metal)
16. $PtCl_4^{2-} + 2$ eq. $NH_3 \longrightarrow$ (show the isomer of substitution product)

On the basis of the 18-electron rule, answer the questions 17 and 18.

17. Identify the second-row transition metal for $(OC)_5M{=}C(OCH_3)(C_6H_5)$
18. Determine the metal-metal bond order for $[(\eta^5\text{-}C_5Me_5)Mn(CO)_2]_2$

19. Give the structural formula for **A** through **D**

$$(\eta^5\text{-}C_5H_5)_2Fe_2(CO)_4 \xrightarrow{Na/Hg} \mathbf{A} \xrightarrow{Br_2} \mathbf{B} \xrightarrow{LiAlH_4} \mathbf{C} \xrightarrow{PhNa} \mathbf{A} + \mathbf{D}\ \text{(a hydrocarbon)}$$

υ_{CO} = 1961, 1942, 1790 cm^{-1} for $(\eta^5\text{-}C_5H_5)_2Fe_2(CO)_4$

A has strong IR bands at 1880 and 1830 cm^{-1}.

C has a ^1H NMR spectrum consisting of two singlets of relative intensity 1:5 at approximately δ -12 ppm and δ 5 ppm, respectively.

20. Calculate the lattice energy of LiF from the following data.
F_2 bond energy = 158 kJ/mol, ΔH_f(LiF) = -796 kJ/mol, ΔH_{sub}(Li) = 161 kJ/mol, IE(Li) = 531 kJ/mol, EA(F) = 328 kJ/mol

21. SF_4 has C_{2v} symmetry.
(a) Apply the group theory treatment to predict the possible hybridization for the S atom in SF_4.
(b) Determine the number and irreducible representations of IR-active S—F stretching bands.

C_{2v}	E	C_2	$\sigma_v(xz)$	$\sigma_v'(yz)$		
A_1	1	1	1	1	z	x^2, y^2, z^2
A_2	1	1	-1	-1	R_z	xy
B_1	1	-1	1	-1	x, R_y	xz
B_2	1	-1	-1	1	y, R_x	yz

The Periodic Table

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.00794																	2 He 4.00260
3 Li 6.941	4 Be 9.01218											5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.998403	10 Ne 20.1797
11 Na 22.98977	12 Mg 24.305											13 Al 26.98154	14 Si 28.0855	15 P 30.97376	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.41	49 In 114.82	50 Sn 118.710	51 Sb 121.757	52 Te 127.60	53 I 126.9045	54 Xe 131.29
55 Cs 132.9054	56 Ba 137.33	57 *La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.9665	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0254	89 †Ac 227.0278	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Uun	111 Uuu	112 Uub	113 Uut	114 Uuq				

*Lanthanide series	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967
†Actinide series	90 Th 232.0381	91 Pa 231.0359	92 U 238.0289	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)