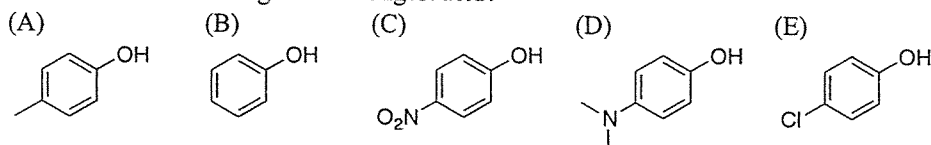


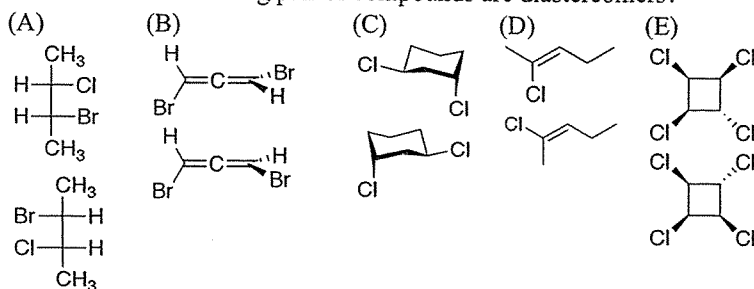
第一部份 有機化學 (共 50 分)

Part I. 單選題(第 1 ~ 4 題). Please select the most appropriate answer for the following questions. There is only one correct answer for each question. 請於試卷內之「選擇題作答區」依序作答。(每題 2 分, 共 8 分)

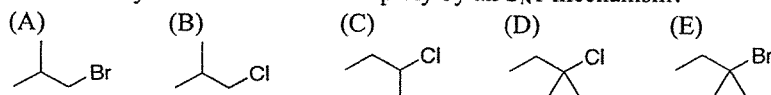
1. Which of the following is the strongest acid?



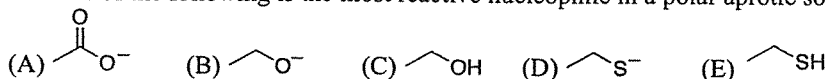
2. Which of the following pair of compounds are diastereomers?



3. Which alkyl halide reacts more rapidly by an S_N1 mechanism?

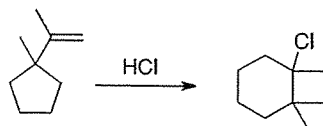


4. Which of the following is the most reactive nucleophile in a polar aprotic solvent?

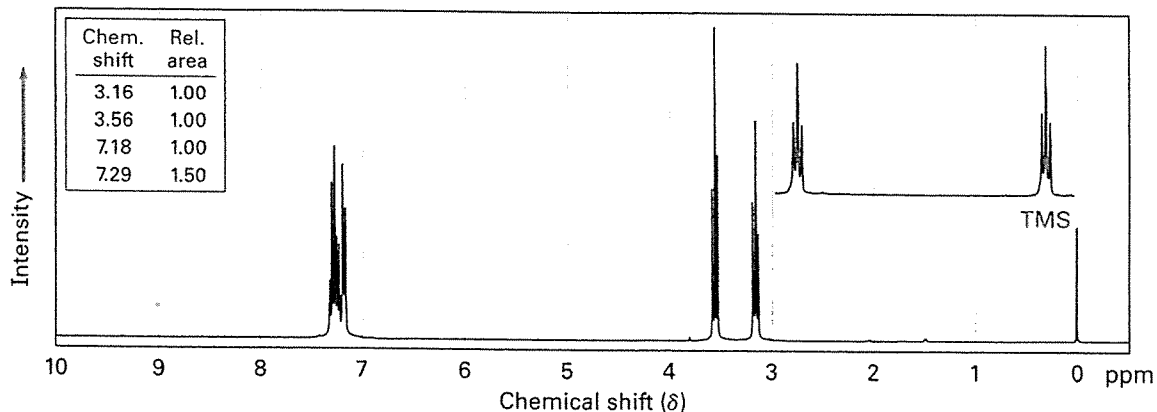


Part II. 問答題(第 5 ~ 7 題). Please provide a short answer for the following questions. 請於試卷內之「非選擇題作答區」依題號順序作答。(共 9 分)

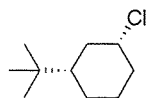
5. Please provide a mechanism for the following transformation. (4 分)



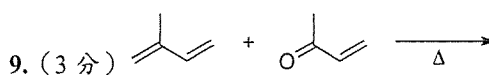
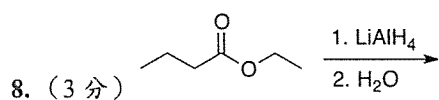
6. The ^1H NMR spectra of the compound $\text{C}_8\text{H}_9\text{Br}$ is shown below. Please propose a structure for the compound below. (3 分)



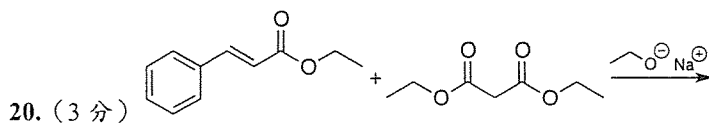
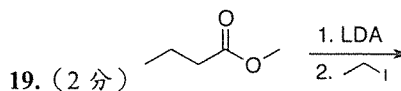
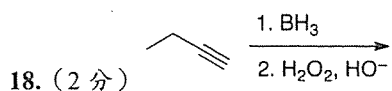
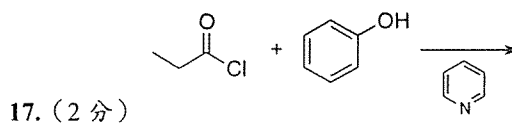
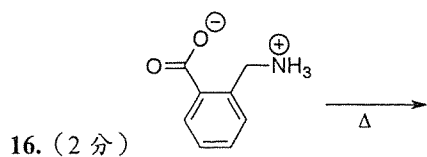
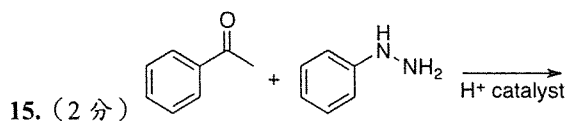
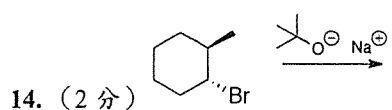
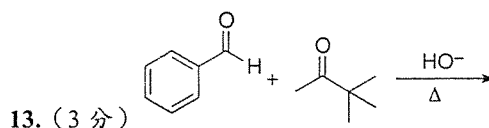
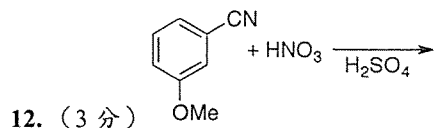
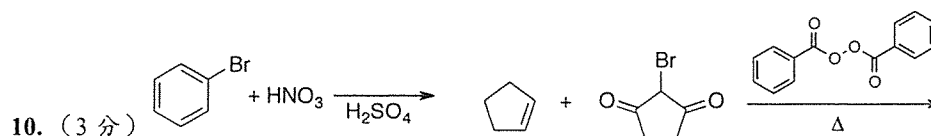
7. Please draw the lowest energy chair conformation for the following compound. (2分)



Part III. 簡答題(第 8 ~ 20 題). Please draw the major product(s) for the following reactions. Please include stereochemistry when necessary. Line angle structures (also known as skeletal structures) are preferred. 請於試卷內之「非選擇題作答區」依題號順序作答。(共 33 分)



11. (3分)



接次頁

第二部份無機化學 (共 50 分)

多重選擇題(第 21 ~ 30 題). 每題至少有一個正確選項, 每題 5 分, 請依題號順序於『選擇題作答區』內作答

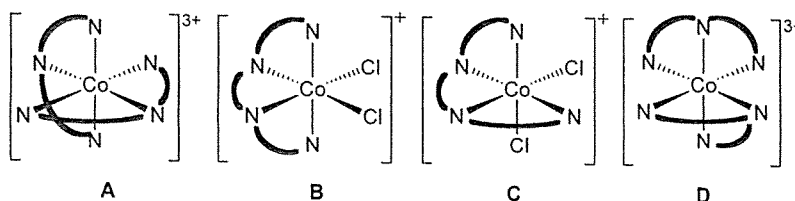
21. Which of the following statement(s) about fluorine and chlorine is(are) correct?

- a. $\text{Cl}_2(g)$ has smaller bond dissociation energy than $\text{F}_2(g)$.
- b. NaCl has smaller lattice energy than NaF .
- c. Fluorine is more electronegative.
- d. Fluorine has higher electron affinity.
- e. Fluoride has higher hydration energy.

22. Which of the following description(s) of SO_3 is(are) correct?

- a. SO_3 and NH_3 belong to the same point group.
- b. SO_3 is a polar molecule.
- c. SO_3 has three mirror planes.
- d. SO_3 has six degrees of vibrational freedom.
- e. The symmetric stretching vibration of SO_3 is IR inactive.

23. Which of the following description(s) is(are) correct?



- a. Compound **A** belongs to C_{2v} symmetry point group.
- b. The absolute configuration of compound **B** is Λ
- c. The absolute configuration of compound **C** is Λ
- d. The absolute configuration of compound **D** is $\Lambda\Delta\Delta$
- e. None of the above.

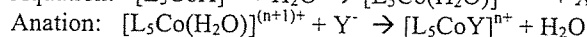
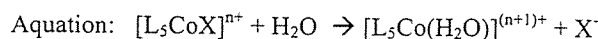
24. How to achieve high spin transition metal complexes?

- a. Use π -donating ligands.
- b. Use 3rd row transition metal.
- c. Use metal ions in high oxidation state.
- d. Use metal ions with large pairing energy.
- e. Increase the temperature of environment.

25. Which of the following description(s) of $[\text{MX}_6]^{n-}$ ($M = 1^{\text{st}}$ row transition metal; $X = \text{F}, \text{Cl}, \text{Br}, \text{and I}$) is(are) correct?

- a. In all cases, the measured Racah parameter B of M^{n+} is always smaller than that of free metal ion.
- b. Racah parameter B of iodide complex is the smallest in the series due to the poor overlap between p orbital of iodide and d orbital of metal ion.
- c. Crystal field splitting Δ_o of iodide complex is smaller than that of fluoride complex because iodide is less electronegative than fluoride.
- d. One electron oxidation of the complex increases both Racah parameter B and crystal field splitting Δ_o .
- e. By changing the M from 1st row to 3rd row transition metal ion, Racah parameter B and crystal field splitting Δ_o of the complex will be increased.

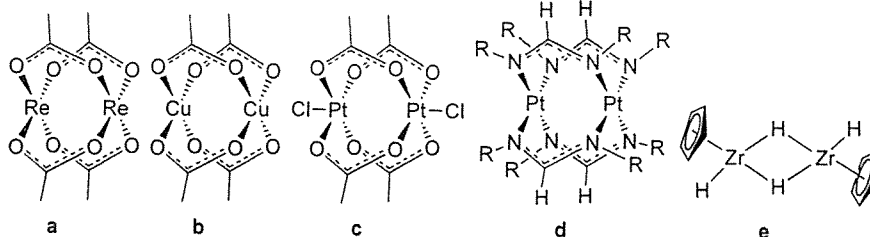
26. To investigate the ligand substitution mechanism of Co^{3+} , a series of aquation and anation reactions were carried out in water. Ligand (L) can be neutral or anionic.



If the reaction follows the intimate dissociative mechanism, which of the following phenomenon should be observed?

- The anation reaction rate is highly dependent on the nature of Y^-
 - The observed transition state volume change is positive
 - Limiting rate constant for anation is always smaller than the water exchange reaction ($\text{Y}^- = \text{H}_2\text{O}$)
 - For a specific X^- , the aquation reaction rate is not affected by the overall charge of the complex.
 - The anation rate is first order to $[\text{Y}^-]$ at low concentration of Y^- .
27. If the absorption spectrum of $[\text{Ni}(\text{NH}_3)_6]^{2+}$ contains three peaks at 9500 , 16200 , and 27500 cm^{-1} , please select the correct answer(s).
- The ground state term of free Ni^{2+} ion is 3F_2
 - The absorption peak centered at 16200 cm^{-1} is assigned to transition from ${}^3A_{2g}$ to ${}^3T_{1g}$
 - Crystal field splitting of the complex is 11875 cm^{-1} .
 - Racah parameter B of the complexes is 1013 cm^{-1} .
 - None of the above.

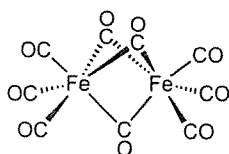
28. Which of the following compound(s) features metal-metal bond?



29. For metal carbonyl complexes, which of the following statement(s) is(are) correct?

- CO is a soft ligand and tends to form stable complexes with high oxidation state metal ions.
- The CO stretching frequencies of $[\text{Ni}(\text{CO})_3\text{L}]$ complexes can be used to quantify the electron donating ability and steric bulkiness of L.
- For $[\text{Mn}(\text{CO})_6]^+$ and $[\text{V}(\text{CO})_6]^-$, the vanadium complex is more electron rich and has higher CO stretching frequency.
- The observed CO stretching frequency in $(\text{CO})_5\text{W}=\text{C}(\text{OMe})\text{Ph}$ is higher than that of $\text{W}(\text{CO})_6$.
- None of the above.

30. As shown below, diiron nonacarbonyl ($\text{Fe}_2(\text{CO})_9$) conforms to D_{3h} symmetry with three bridging CO and six terminal CO groups. Please select the correct answer(s).



D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$		
A_1'	1	1	1	1	1	1	R_z	$x^2 + y^2, z^2$
A_2'	1	1	-1	1	1	-1		(x, y)
E'	2	-1	0	2	-1	0		
A_1''	1	1	1	-1	-1	-1		
A_2''	1	1	-1	-1	-1	1	z	
E''	2	-1	0	-2	1	0	(R_x, R_y)	(xz, yz)

- The symmetries of d orbitals in D_{3h} point group are $A_1' + E' + E''$
- The stretching vibration symmetries of the three bridging CO groups are $A_1'' + E'$
- The stretching vibration symmetries of the six terminal CO groups are $A_1' + A_2'' + 2E'$
- There are totally three IR active CO stretching vibrations.
- None of the above.