科目：441 綜合化學

系組：應化系

考生注意：1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 試題隨卷繳回。

1. Briefly describe the principles of the following acronyms in analytical chemistry. (30 points, 6 points each)

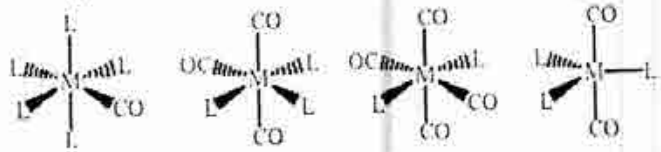
(A) SPM (B) SIM (C) AES (D) CARS (E) FT

2. Briefly describe and explain the uncertainty principle. (10 points)

3. Briefly describe the principles and applications of quantum mechanics in chemistry. (10 points)

4. (5 points) Please match each molecule below with the following point groups: C_{4v}, C_{2v}, D_{3h}, and D_{4h}.

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



5. (5 points) For three amine complexes for cobalt: (i) $[Co(NH_3)_6]^{2+}$ (ii) $[Co(NH_3)_6]^{3+}$ (iii) $[Co(NH_3)_4]^{2+}$, please answer the following questions. (a) what are the molecular structures ? (b) what are their corresponding electronic configuration for the central Co metals? (c) assign the crystal field splitting energies for these three complexes, which are 5900 cm^{-1}, 10200 cm^{-1}, and 22900cm^{-1}.

6. (5 points) What is the electronic configuration of the following metal cations (a) tetrahedral Zr^{3+} (b) octahedral Rh^{2+}? If there are multiple solutions give both and suggest which be preferred or what structural changes would occur.

7. (5 points) Four acid-base reactions are listed below. For each reaction, please identify which reactants is acid and which is the base. Label each reactant either "acid" or "base".

甲、 $[Cr(H_2O)_6]^{2+} + 6\,NH_3 \rightarrow [Cr(NH_3)_6]^{2+} + 6\,H_2O$;

乙、 $C_6H_5^- + NH_3 \rightarrow C_6H_6 + NH_4^+$

丙、 $AsF_5 + 2ClF \rightarrow (Cl_2F)^+ + (AsF_6)^-$

丁、 $Pt + XeF_4 \rightarrow PtF_4 + Xe$

8. (5 points) Please sketch the region in the line spectrum of gas-phase N (nitrogen) atoms corresponding to a transition from a higher-lying ^4D term to a lower-lying ^4P term. The ^4D term derives from the $[He]2s^22p^23p^1$ configuration, and the ^4P term derives from the $[He]2s^22p^23s^1$ configuration. Assume that your spectrometer has sufficient resolution to distinguish the small spin-orbit couplings that exist in the N atom. Please provide the appropriately labeled energy-level diagram, and cite any selection rules you have applied.

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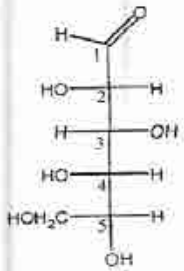
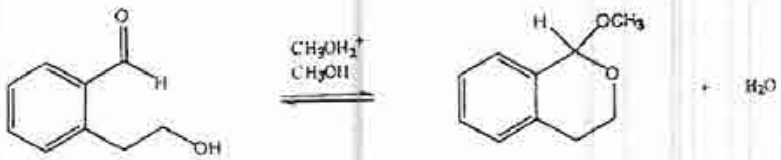
9. (5 points) The structure given below is that of a typical 6-carbon aldose sugar in its aldehyde form. Please mark star on the stereocenters in this structure and calculate how many different 6-carbon aldose sugars there are.

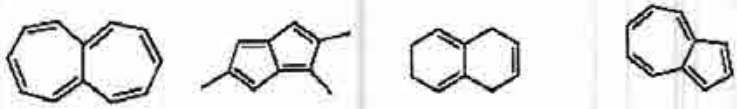


10. (5 points) Write a mechanism for the following reaction in the forward direction. Under what conditions would the above equilibrium be shifted toward the starting material?



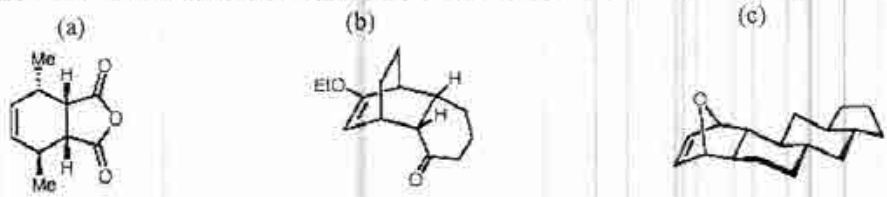
11. (5 points) Label each of the following molecules as aromatic, non-aromatic, or anti-aromatic.

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



12. (5 points) Draw the appropriate diene and dienophile that you would use to synthesize each of the following compounds via a Diels-Alder reaction. Be sure to clearly indicate stereochemistry where appropriate.

(a) (b) (c)



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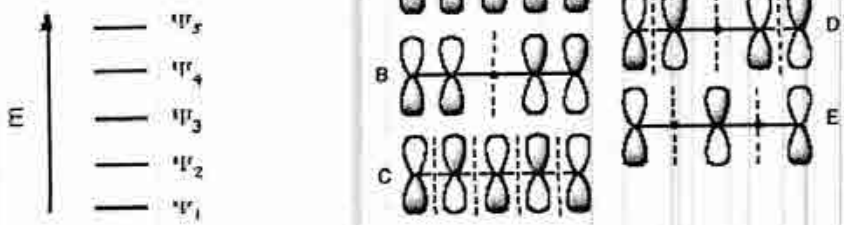
13. (5 points) Consider the pentyl cation, one resonance form of which is:

(a) Draw ALL important resonance forms of this ion.
(b) Match each of the molecular orbitals A-E for the pentyl cation with its appropriate position in the energy level diagram by writing the letter next to the appropriate Ψn symbol.



(c) Fill the energy level diagram with the correct number of electrons for this ion.
(d) Which molecular orbital best describes the position(s) of positive charge in the pentyl cation?