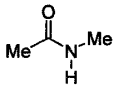
有機化學部分 (50 分)

I. Name the compounds or draw the structures of the compounds. (1 pt each, 6 pts)

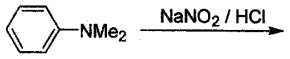
1. 

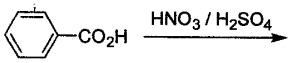
2. 

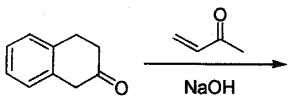
3. 

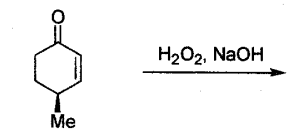
4. *m*CPBA　　5. hydroquinone　　6. NBS

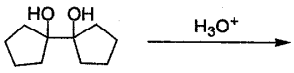
II. Give the expected major product with appropriate stereochemistry, if necessary. (2 pts each, 20 pts)

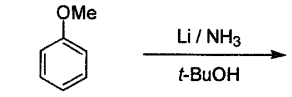
1. 

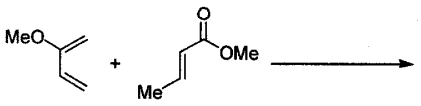
2. 

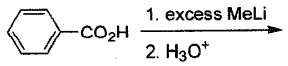
3. 

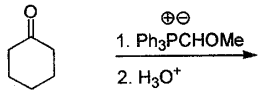
4. 

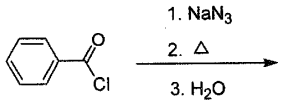
5. 

6. 

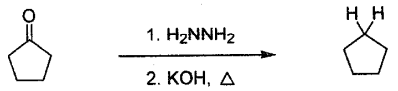
7. 

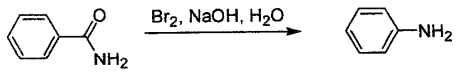
8. 

9. 

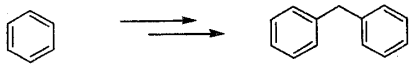
10. 

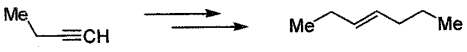
III. Propose a mechanism for the following reactions. (5 pts each, 10 pts)

1. 

2. 

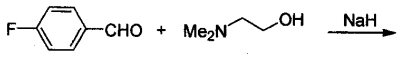
IV. Propose a synthetic scheme for each of the following compounds from the readily available starting materials. (3 pts each, 9 pts)

1. 

2. 

3. 

V. What is the structure of the product of this reaction and how is it formed? (5 pts)



$C_{11}H_{15}NO_2$

υ_{max} (cm^{-1}): 1730

δ_C (ppm): 29, 41, 64, 115, 130, 132, 164, 191

δ_H (ppm): 2.32 (6H, s), 3.05 (2H, t), 4.20 (2H, t)
6.97 (2H, d), 7.82 (2H, d), 9.97 (1H, s)

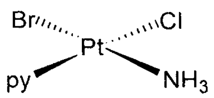
無機化學部分（共五十分，20 題單選，每題 2.5 分）

1. Select the correct order of metal ion softness:
   (A) $Zr^{4+} > Ti^{4+} > Mn^{3+} > Li^{+} > Cu^{+} < Au^{+}$
   (B) $Au^{+} > Cu^{+} > Li^{+} > Mn^{3+} > Ti^{4+} > Zr^{4+}$
   (C) $Ti^{4+} > Zr^{4+} > Li^{+} > Mn^{3+} > Au^{+} > Cu^{+}$
   (D) $Au^{+} > Cu^{+} > Mn^{3+} > Li^{+} > Zr^{4+} > Ti^{4+}$

2. Predict the ionic size for the following ions:
   (A) $Sr^{2+} > Rb^{+} > Br^{-} > Se^{2-}$
   (B) $Se^{2-} > Br^{-} > Rb^{+} > Sr^{2+}$
   (C) $Br^{-} > Se^{2-} > Sr^{2+} > Rb^{+}$
   (D) $Rb^{+} > Sr^{2+} > Se^{2-} > Br^{-}$

3. Predict the number of unpaired electrons for the following complex ions:
   $[Cr(CN)_6]^{4-}$; $[Cu(NH_3)_4]^{2+}$(planar) ; $Fe(CN)_6]^{3-}$
   (A) 1 ; 2 ; 2
   (B) 2 ; 1 ; 2
   (C) 2 ; 1 ; 1
   (D) 1 ; 2 ; 1

4. What procedures must one follow in order to synthesize the following complex starting from $[PtCl_4]^{2-}$, NH_3, Br^- and pyridine (py).



   (A) $[PtCl_4]^{2-}$ + py + Br^- + NH_3
   (B) $[PtCl_4]^{2-}$ + 2py + Br^- + NH_3
   (C) $[PtCl_4]^{2-}$ + py + NH_3 + Br^-
   (D) $[PtCl_4]^{2-}$ + NH_3 + Br^- + py

5. Silver crystallizes in a cubic closest packed structure. The radius of a silver atom is 1.44 Å Calculate the density of solid silver (the average atomic mass of Ag is 107.9 amu/atom; $\sqrt{2} = 1.414$).
   (A) 10.6 g/cm^3
   (B) 67.4 g/cm^3
   (C) 4.07 g/cm^3
   (D) 6.74 g/cm^3

6. What is the value of Δ (in kJ/mol) when it requires radiation with λ = 510 nm to excite an electron in $[Ti(H_2O)_6]^{3+}$ between *d* orbitals in an octahedral crystal field? (Planck's constant, $h = 6.626 \times 10^{-34}$ Js)
   (A) 432.7 kJ/mol
   (B) 324.1 kJ/mol
   (C) 234.7 kJ/mol
   (D) 134.6 kJ/mol

7. What are the point groups for the isomeric complexes, *fac*-$MA_3(CO)_3$ and *mer*-$MA_3(CO)_3$?
   (A) *fac*- C_{2h}; *mer*- D_{3d}
   (B) *fac*- D_{2d}; *mer*- D_{3h}
   (C) *fac*- D_{3h}; *mer*- C_{2h}
   (D) *fac*- C_{3v}; *mer*- C_{2v}

8. Based on the concept of VSEPR, select the correct order of bond angles for the following series of compounds?
   (A) $NH_3 < PH_3 < AsH_3 < SbH_3$
   (B) $SbCl_3 < SbBr_3 < SbI_3$
   (C) $CH_4 < NH_3 < H_2O$
   (D) $BF_3 < BF_2Cl < BF_2H$

9. For the following electron configurations of the metals with a perfect octahedral ligand field (ML_6) predict the degree of their Jahn-Teller effects.
   (A) d^3 = high spin d^4 > high spin d^6 > high spin d^5
   (B) d^3 > low spin d^5 > low spin d^4 = low spin d^6
   (C) d^3 = high spin d^5 < high spin d^6 < high spin d^4
   (D) d^3 < low spin d^4 < low spin d^5 = low spin d^6

10. Which one of the following reactions is likely to proceed by an inner-sphere mechanism?
    (A) $[Co(CN)_5]^{3-}$ + $[Co(NH_3)_6]^{3+}$
    (B) $[Ru(NH_3)_6]^{2+}$ + $[Co(NH_3)_6]^{3+}$
    (C) $[Cr(H_2O)_6]^{2+}$ + $[Co(NH_3)_6]^{3+}$
    (D) $[Co(CN)_5]^{3-}$ + $[Co(NH_3)_5(Cl)]^{2+}$

11. Select the correct order of magnitudes of Δ_o values for the following ligands upon their complexation with Cr(III) metal ion. F^-, Cl^-, CN^-, NH_3, H_2O and en (ethylenediamine).
    (A) en > NH_3 > H_2O > F^- > Cl^- > CN^-
    (B) CN^- > en > NH_3 > H_2O > Cl^- > F^-
    (C) F^- > Cl^- > en > NH_3 > H_2O > CN^-
    (D) CN^- > Cl^- > F^- > en > NH_3 < H_2O

12. Assign the correct order of the energy of carbonyl stretching bands (ν_{CO}) for the following *facial*-molybdenum complexes.
    (A) $Mo(CO)_3(PF_3)_3$ > $Mo(CO)_3(PCl_3)_3$ > $Mo(CO)_3(PClPh_2)_3$ > $Mo(CO)_3(PMe_3)_3$
    (B) $Mo(CO)_3(PMe_3)_3$ > $Mo(CO)_3(PClPh_2)_3$ > $Mo(CO)_3(PCl_3)_3$ > $Mo(CO)_3(PF_3)_3$
    (C) $Mo(CO)_3(PMe_3)_3$ > $Mo(CO)_3(PF_3)_3$ > $Mo(CO)_3(PCl_3)_3$ > $Mo(CO)_3(PClPh_2)_3$
    (D) $Mo(CO)_3(PClPh_2)_3$ > $Mo(CO)_3(PCl_3)_3$ > $Mo(CO)_3(PF_3)_3$ > $Mo(CO)_3(PMe_3)_3$

13. Which of the following complexes supported by η^n- or η^m- C_xH_y ligands dose give the hapticity (n or m) equal to 1?
    (A) $(\eta^n\text{-}C_5H_5)(\eta^m\text{-}C_5H_5)W(CO)_2$
    (B) $(\eta^n\text{-}C_3H_5)Mn(CO)_5$
    (C) $[(\eta^n\text{-}C_7H_7)Mo(CO)_3]^+$
    (D) $(\eta^n\text{-}C_6H_6)Fe(PMe_3)_3$

14. Select the highest bond order between metals for the following complexes: $[(CO)_3Co(\mu\text{-}CO)]_2$, $[(\eta^5\text{-}Cp)Rh(\mu\text{-}CO)]_2$, $[(\eta^5\text{-}Cp)_2Zr(I)]_2$, $[(\eta^5\text{-}Cp)Mo(CO)_2]_2$

(A) $[(CO)_3Co(\mu\text{-}CO)]_2$
(B) $[(\eta^5\text{-}Cp)Rh(\mu\text{-}CO)]_2$
(C) $[(\eta^5\text{-}Cp)_2Zr(I)]_2$
(D) $[(\eta^5\text{-}Cp)Mo(CO)_2]_2$

15. What is the correct chemical formula for Ammonium oxopentachlorochromate(V)?

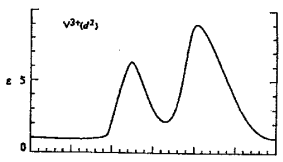
(A) $[CrO(NH_3)Cl_4]Cl$
(B) $[Cd(NH_3)Cl_5]$
(C) $[Cr(NH_3)Cl_5]$
(D) $[NH_4][CrOCl_5]$

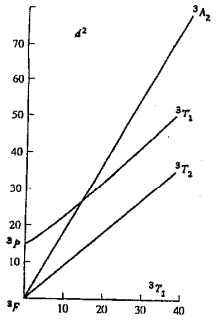
16. Which of the following electronic configuration of a given *d*–block transition metal would show two possible (high spin and low spin) octahedral crystal fields?

(A) d^1
(B) d^3
(C) d^7
(D) d^8

17. For the following electronic spectra of $[V(H_2O)_6]^{3+}$, use the Tanabe-Sugano diagram given below to assign every absorption band with an indication of either an allowed or a forbidden transition and Jahn-Teller distortion if applicable.

(A) spin allowed; $^3T_1 \rightarrow {}^3T_2$; $^3T_1(F) \rightarrow {}^3T_1(P)$; no Jahn-Teller effect
(B) spin allowed; $^3T_1 \rightarrow {}^3T_2$; $^3T_1 \rightarrow {}^3A_2$; no Jahn-Teller effect
(C) spin forbidden; $^3T_1 \rightarrow {}^3T_1$; $^3T_1 \rightarrow {}^3A_2$; strong Jahn-Teller effect
(D) spin forbidden; $^3T_1 \rightarrow {}^3T_2$; $^3T_1(F) \rightarrow {}^3T_1(P)$; strong Jahn-Teller effect





18. Which of the following complexes is paramagnetic?

(A) Octahedral *fac*-$W(CO)_3(CH_3CN)_3$
(B) Square palnnar $Ni(PPh_3)_2Cl_2$
(C) Tetrahedral $Ni(pyridine)_2Br_2$
(D) Octahedral *mer*-$W(CO)_3(CH_3CN)_3$

19. Select the strongest Lewis acid: BF_3, BCl_3, BI_3, BMe_3

(A) BCl_3
(B) BF_3
(C) BMe_3
(D) BI_3

20. Which one is most soluble in water: $MgSO_4$, $CaSO_4$, $SrSO_4$, $BaSO_4$?

(A) $MgSO_4$
(B) $CaSO_4$
(C) $SrSO_4$
(D) $BaSO_4$