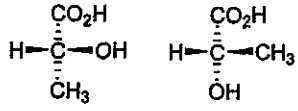
## Part I: Organic Chemistry

一、單選題（共 18 題，每題 2 分，答錯倒扣一分）※注意：請於試卷「選擇題作答區」依題號作答。

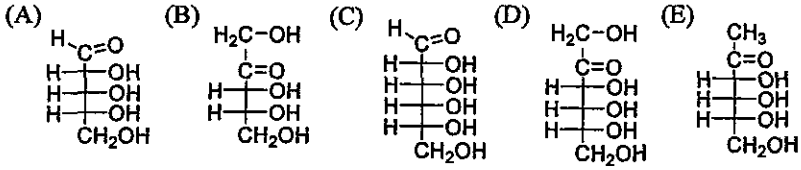
1) The structures shown at the right are

(A) identical compound (B) enantiomers
(C) diastereomers (D) constitutional isomers
(E) conformational isomers

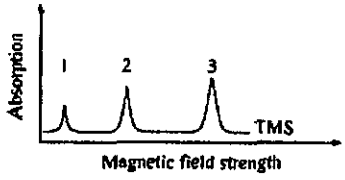


2) A pyranose form is a cyclic hemiacetal with a six-membered ring. Which of the following compounds cannot exist in a pyranose form?

(A) (B) (C) (D) (E)



3) Based on the low-resolution proton NMR spectrum of a particular compound shown at the right, which of the following is(are) true?

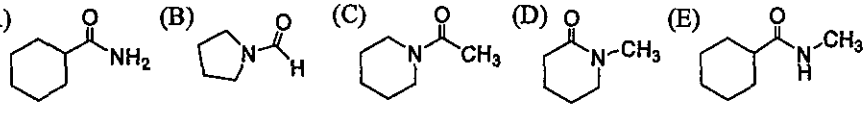



I. There are at least three different types of protons in this compound.
II. There are more protons of the type corresponding to peak 3 than the type corresponding to peak 1.
III. Protons of the type corresponding to peak 2 are more shielded than those corresponding to peak 1.

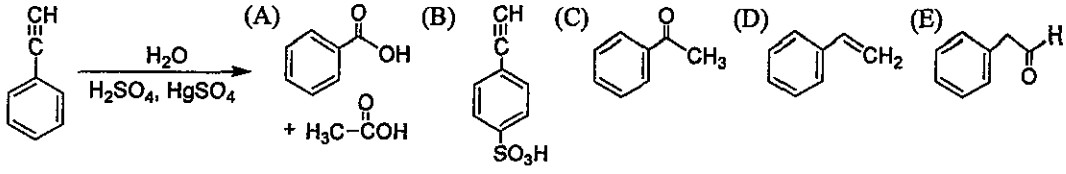
(A) I only (B) II only (C) III only (D) I and II only (E) I, II, and III.

4) Which of the compound can produce a secondary amine with the treatment of $LiAlH_4$ in diethyl ether followed by $H_2O$?

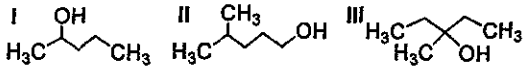
(A) (B) (C) (D) (E)



5) Which of the following is the major product of the reaction sequence shown below?



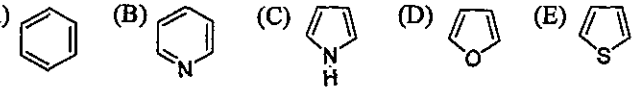

6) Which of the following is the correct order of reactivity from fastest to slowest towards acid-catalyzed dehydration?




(A) I>II>III (B) I>III>II (C) II>III>I
(D) III>I>II (E) III>II>I

7) Which of the following is the strongest base?

(A) (B) (C) (D) (E)



8) The saponification of the optically active ester using isotopically labeled oxygen as shown below would most likely produce which of the following products?

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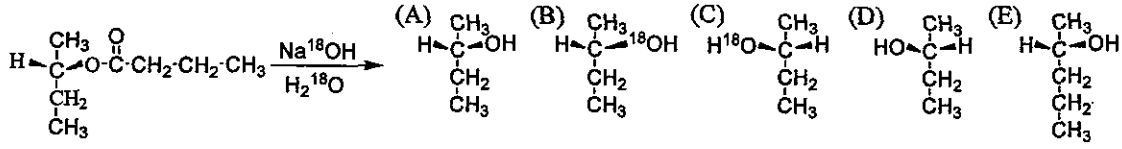
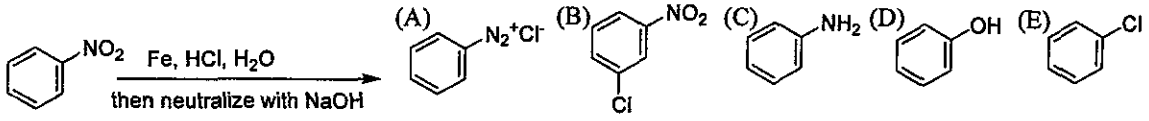
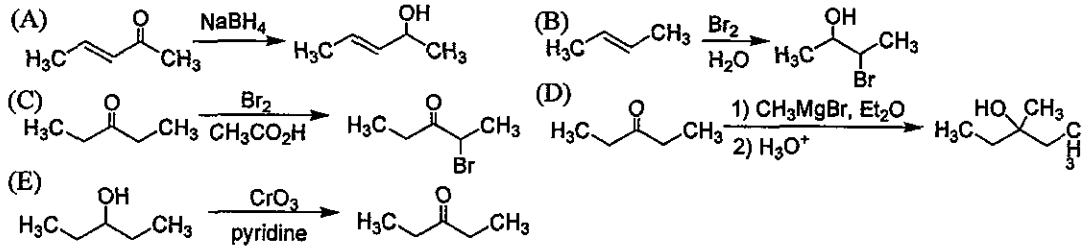



9) What is the major product of the reaction shown below?

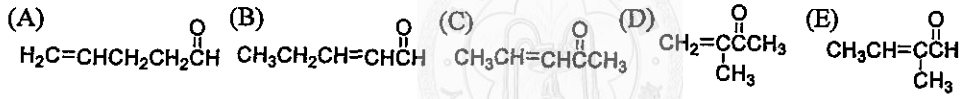



10) In which of the following reaction is an enol an important intermediate?

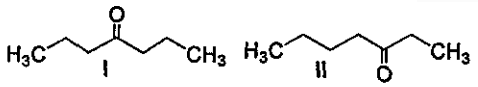



11) Which of the structures below is consistent with the $^1$HNMR data listed?

δ9.5 ppm, singlet, 1H; δ6.5 ppm, quartet, 1H; δ2.0 ppm, doublet, 3H; δ1.8 ppm, singlet, 3H

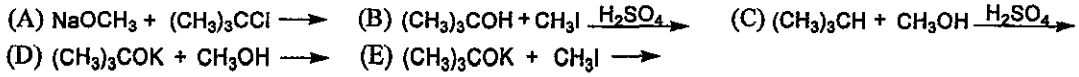



12) The isomeric ketones shown below can be distinguished from each other by the number of signals that they would show in their $^{13}$C NMR spectra. These ketones should show which of the following number of signals.

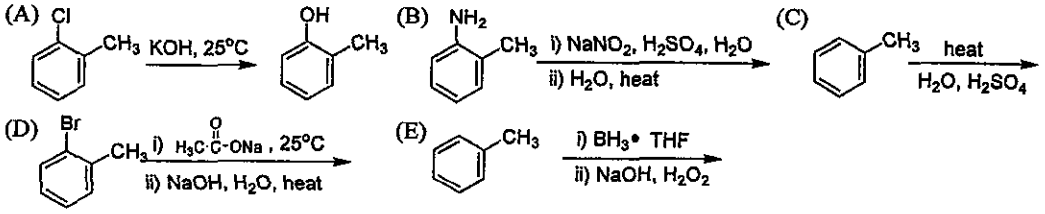



(A) 3 for **I** and 5 for **II**; (B) 3 for **I** and 7 for **II**; (C) 4 for **I** and 7 for **II**; (D) 4 for **I** and 3 for **II**; (E) 5 for **I** and 7 for **II**.

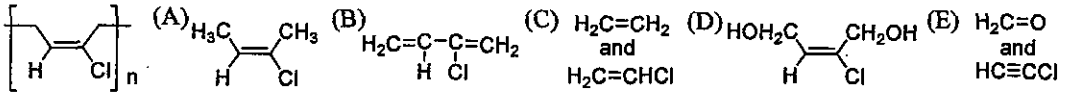
13) Which is the best method for preparing $(CH_3)_3COCH_3$




14) Which of the following is a suitable synthesis of *o*-methylphenol?




15) Which of the following monomers or pair of monomers is used to make the addition polymer neoprene shown below?




16) Which is an incorrect statement?

(A) RSH compounds are stronger acids than ROH compounds.(B) $PH_3$ is a weaker base than $NH_3$.

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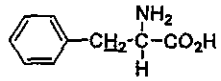
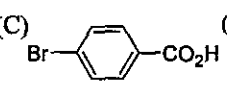
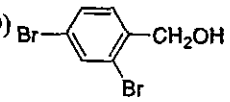
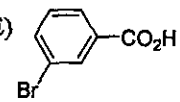
(C) $NH_2^-$ is a stronger base than $OH^-$.(D) $OH^-$ is a stronger base than $OR^-$. (E) $H^-$ is a stronger base than $OR^-$

17) The maximal number of the signals (multiplicity) for the underlined protons in the $^1H$ NMR spectrum is



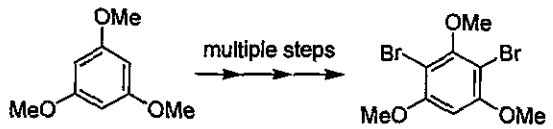
(A) 2; (B) 4; (C) 6; (D) 8; (E) 3

18) Compund **X** exhibits parent peaks at m/z (relative intensity) 200 (50), 202 (100) and 204 (50) in the mass spectrum. Compound **X** is

(A) $HO(CH_2)_{12}OH$ (B) $BrCH_2CH_2CH_2Br$ (C)  (D)  (E) 

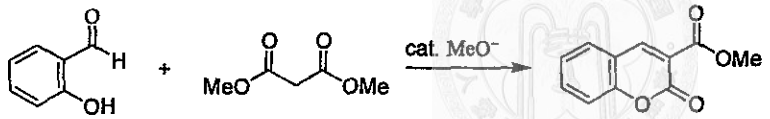
二、問答題（共 2 題，每題 7 分，請詳細表示試劑及電子的移動方向）請於試卷上「非選擇題作答區」依序作答。

19) Provide a synthetic route to prepare compound **B** selectively starting with compound **A**. Show all of the key intermediates and furnish all of the important reagents.




Compound **A**　　Compound **B**

20) Provide a mechanism for the following transformation. Please show all arrow pushing.




## Part II: Inorganic Chemistry

三、單與多選題（共八題每題至少有一正確答案，共 20 正確答案，每正確答案 2 分，答錯倒扣一分）

※ 注意：請於試卷上「非選擇題作答區」依序作答，並應註明作答之大題及小題題號。

21) Given that the mean bond enthalpies of $F_{2(g)}$, $SF_{4(g)}$, and $SF_{6(g)}$ are +158, +343, and +327 kJ/mol, respectively at 25°C, find the reaction enthalpy for the production of $SF_{6(g)}$ from $SF_{4(g)}$. (A) The reaction is exothermic (B) The reaction is endothermic (C) The enthalpy for the reaction is -432 kJ (D) The enthalpy for the reaction is -174 kJ.

22) In a closest packing of spherical particle (P) there are tetrahedral ($T_d$) and octahedral ($O_h$) holes in between layers of P. Which of the following statements are correct?
(A) The packing efficiency of the closest packing is 74% (B) The total number of tetrahedral holes is the same as the total number of packing particles. (C) If all octahedral holes are occupied by particle O the formula of the compound should be $P_2O$. (D) For the solid MX, if $0.225\ X^- < M^+ < 0.414\ X^-$ (where $M^+$ and $X^-$ are radius of $M^+$ and $X^-$, respectively) $M^+$ can fill into the octahedral hole.

23) Organometallic compounds are made of metal and ligands such as Cp (cyclopentadienyl), CO, $CPh_2$, cod (cyclooctadiene) etc. Many compounds obey the 18-electreon rule (EAN rule). Which ones of the following compounds obey the 18-electron rule.
(A) $CpMn(CO)_2(CPh_2)$, (B) $(Me_3CO)_3W(CCMe_3)$, (C) $(\eta^6\text{-}C_6H_6)Mo(MeCN)_3$, (D) $[Ni(CO)_3(NO)]^-$ (M-N-O is linear)

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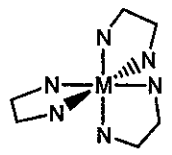
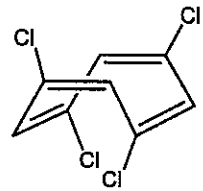
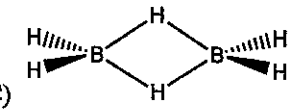
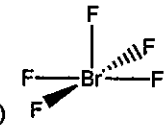
24) Applying the Lewis Acid-Base concept, identify the acid and base in the following reactions.
(A) In the reaction of $BF_3 + 2\ ClF \rightarrow [Cl_2F]^+ + BF_4^-$, $BF_3$ is acid and ClF is base. (B) In the reaction of $SbF_5 + 2\ HF \rightarrow [H_2F]^+ + SbF_6^-$, $SbF_5$ is base and HF is acid. (C) In the reaction of $Sn + 2\ NOCl \rightarrow SnCl_2 + 2\ NO$ (in $N_2O_4$ solvent), Sn is acid and NOCl is base. (D) In the reaction of $SO_2 + 2\ ClO_3^- \rightarrow 2\ ClO_2 + SO_4^{2-}$, $SO_2$ is acid and $ClO_3^-$ is base.

25) An improper rotation (rotation-reflection) $S_n$ consists of a rotation $C_n$ followed by reflection in the plane perpendicular to the $C_n$ axis. The $S_1$ operation is identical to the σ operation and the $S_2$ operation is identical to the *i* operation. Select molecules that posses improper rotation $S_n$ with n>2.

(A) 

(B) 

(C) 

(D) 


26) Given the following half cell emf diagram for osmium:

$$OsO_4 \xrightarrow[\langle I\rangle]{1.0} OsCl_6^{2-} \xrightarrow[\langle II\rangle]{0.85} OsCl_6^{3-} \xrightarrow[\langle III\rangle]{0.4} Os^{2+} \xrightarrow[\langle VI\rangle]{0.85} Os$$

26.1) Which one(s) of the following species would be unstable in 1 m HCl?
(A) $OsO_4$ (B) $OsCl_6^{2-}$ (C) $OsCl_6^{3-}$ (D) $Os^{2+}$.
26.2) Which couple(s) would remain unchanged in their emf on altering the pH?
(A) <I> (B) <II> (C) <III> (D) <VI>.
26.3) The half cell emf value for $OsO_4 \rightarrow Os$ is
(A) 0.77 (B) 0.87 (C) 3.10 (D) 1.55.
26.4) Mixing $OsO_4$ with Os in contact with 1 m HCl should result in formation of
(A) $OsCl_6^{2-}$ (B) $OsCl_6^{3-}$ (C) $Os^{2+}$ (D) no reaction.

27) The number of unpaired electrons (UE) and the ligand field stabilization energy (LFSE) can be calculated by the simple crystal field theory for an octahedral complex. Choose from the following complexes that have both the correct number of unpaired electrons and the ligand field stabilization energy.
(A) $[Ru(NH_3)_6]^{3+}$, UE: 1; LFSE: -20Dq (B) $[Fe(CN)_6]^{4-}$, UE: 4; LFSE: -24Dq. (C) $[PtCl_6]^{2-}$, UE: 1; LFSE: -24Dq. (D) $[Co(H_2O)_6]^{3+}$, UE: 1; LFSE: -24Dq.

28) There are geometrical, optical, linkage and other isomers in transition metal complexes. Choose the correct statements.
(A) The total number of isomers for $[Co(NH_3)_2(H_2O)_2Cl_2]^+$ including enantiomers are 6 (B) Octahedral complex $[M(a_3b)(ee)]$ where (ee) is a bidentate ligand has 10 isomers (C) Tetrahedral complex $M(a_2cd)$ has optical isomer (D) $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$ are ionization isomers.

四、解釋名詞（共5題，每題2分）※ 注意：請於試卷上「非選擇題作答區」依序作答，並應註明作答之大題及小題題號。
29) olefin metathesis. 30) nephelauxetic series. 31) diagonal relationship. 32) homoleptic. 33) Madelung constant.

**試題隨卷繳回**