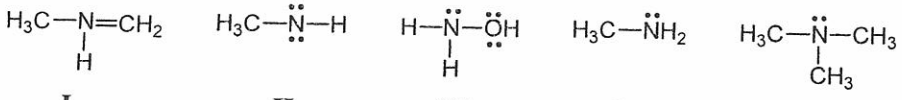
注意：本試題包含單選題及問答題兩部份

Part I. 單選題 （25 題，50 分） ※ 本大題請於試卷內之「選擇題作答區」依序作答。

1. In which structure(s) below does nitrogen have a formal charge of +1?



I II III IV V

(A) I
(B) II and IV
(C) III and V
(D) I and V
(E) I and V

2. The synthesis of an alkyne precursor to 2,2-dimethylheptane is accomplished most effectively by the reaction between these two reagents:

(A) $CH_3CH_2CH_2C{\equiv}CNa$ and $(CH_3)_3CBr$
(B) $CH_3CH_2C{\equiv}CNa$ and $(CH_3)_3CCH_2Br$
(C) $(CH_3)_3CC{\equiv}CNa$ and $CH_3CH_2CH_2Br$
(D) $(CH_3)_3CCH_2CH_2C{\equiv}CH$ and CH_3CH_2I
(E) $HC{\equiv}CNa$ and $(CH_3)_3CCH_2CH_2Br$

3. Which is a *meso* compound?

(A) (2*R*,3*R*)-2,3-Dibromobutane
(B) (2*R*,3*S*)-2,3-Dibromopentane
(C) (2*R*,4*R*)-2,3-Dibromopentane
(D) (2*R*,4*S*)-2,3-Dibromopentane
(E) (2*R*,4*S*)-2,4-Dibromohexane

4. Which compound would show optical activity?

(A) *cis*-1,4-Dimethylcyclohexane
(B) *trans*-1,4-Dimethylcyclohexane
(C) *cis*-1,4-Dimethylcycloheptane
(D) *trans*-1,4-Dimethylcycloheptane
(E) More than one of these.

5. The rate equation for a nucleophilic substitution reaction of a tertiary alkyl bromide (R-Br) with I^- ion would be:

(A) Rate = k [RBr]
(B) Rate = k [I^-]
(C) Rate = k [RBr][I^-]
(D) Rate = k [RBr]^2[I^-]
(E) Rate = k [RBr][I^-]^2

6. Consider the substitution reaction that takes place when (R)-3-bromo-3-methylhexane is treated with methanol. Which of the following would be true?

(A) The reaction would take place only with inversion of configuration at the stereogenic center.
(B) The reaction would take place only with retention of configuration at the stereogenic center.
(C) The reaction would take place with racemization.
(D) No reaction would take place.
(E) The alkyl halide does not possess a stereogenic center.

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7. Which nucleophilic substitution reaction is not likely to occur?

(A) $I^- + CH_3CH_2{-}Cl \longrightarrow CH_3CH_2{-}I + Cl^-$

(B) $I^- + CH_3CH_2{-}OH \longrightarrow CH_3CH_2{-}I + OH^-$

(C) $CH_3O^- + CH_3CH_2{-}Br \longrightarrow CH_3CH_2{-}OCH_3 + Br^-$

(D) $I^- + CH_3CH_2{-}Br \longrightarrow CH_3CH_2{-}I + Br^-$

(E) $OH^- + CH_3CH_2{-}Cl \longrightarrow CH_3CH_2{-}OH + Cl^-$

8. Rearrangements are likely to occur in which of the following reaction types?

(A) S_N1 reactions　(B) S_N2 reactions　(C) E1 reactions

(D) E2 reactions　(E) Both S_N1 and E1 reactions

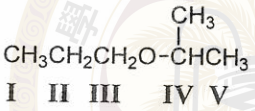
9. What compound would yield an equimolar mixture of $CH_3CH_2CH_2CHO$ and CH_3CHO upon treatment with O_3, followed by Zn/HOAc?

(A) 1-Hexene　(B) *cis*-2-Hexene

(C) *trans*-2-Hexene　(D) More than one of these

(E) None of these

10. Which proton(s) of the compound below would appear as a triplet in the ^1H NMR spectrum?



(A) The protons on carbon **II**　(B) The protons on carbon **I** and **V**

(C) The protons on carbon **III** and **V**　(D) The protons on carbon **III** and **IV**

(E) The protons on carbon **V**

11. The free radical chlorination of (*R*)-2-chloropentane forms a mixture of dichloropentanes which includes:

(A) three optically active compounds.　(B) two achiral compounds.

(C) two meso compounds.　(D) one pair of diastereomers.

(E) one racemic mixture.

12. Which of the following can be described as "optically active, primary alcohol"?

(A) $CH_3CH_2CH_2CH_2CH_2OH$　(B) $(CH_3)_2CHCH_2CH_2OH$　(C) $CH_3CH_2CH(CH_3)CH_2OH$

(D) $(CH_3)_2CHCHOHCH_3$　(E) Two of the above.

13. The success in converting low molecular weight 1° alcohols to aldehydes by use of $K_2Cr_2O_7/H_2SO_4$ as oxidant can be attributed to the fact that:

(A) Dichromate is a relatively weak oxidizing agent.

(B) The presence of H_2SO_4 limits the oxidation.

(C) The aldehyde can be separated, as formed, by distillation.

(D) Aldehydes are not oxidized by the $K_2Cr_2O_7/H_2SO_4$ mixture.

(E) Hydrogen bonding occurs between the alcohol and the acid present.

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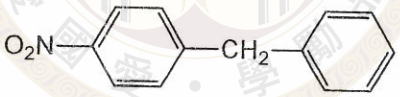
14. The reaction of lithium di-*sec*-butylcuprate with isopentyl bromide yields:
(A) 2,5-Dimethylheptane (B) 2,6-Dimethylheptane (C) 3,5-Dimethylheptane
(D) 3,4-Dimethylheptane (E) 3,6-Dimethylheptane

15. Which of the reagents listed below would efficiently accomplish the transformation of $CH_3CH_2CH{=}CHCH_2CH_2CHO$ into $CH_3CH_2CH{=}CHCH_2CH_2CH_2OH$?
(A) $KMnO_4$ (B) $NaBH_4$ (C) Br_2 in CCl_4
(D) H_2, Ni (E) Two of the above

16. Which of the following could be used to synthesize 3-bromocyclopentene?
(A) Cyclopentene + Br_2, CCl_4, 25°. (B) Cyclopentene + NBS, CCl_4 (ROOR).
(C) 3-Cyclopentenol + PBr_3. (D) Both A) and B).
(E) Both B) and C).

17. Which of the following is NOT true of benzene?
(A) Benzene tends to undergo substitution rather than addition reactions, even though it has a high index of hydrogen deficiency.
(B) All of the hydrogen atoms of benzene are equivalent.
(C) The carbon-carbon bonds of benzene are alternately short and long around the ring.
(D) Only one *o*-dichlorobenzene has ever been found.
(E) Benzene is more stable than the hypothetical compound 1,3,5-cyclohexatriene.

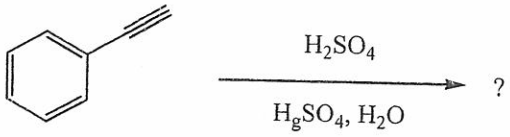
18. What might be predicted to happen when the following substance undergoes Friedel-Crafts acylation?



A B

(A) Substitution occurs in ring B, *p*- to the methylene group.
(B) Substitution occurs in ring A, *o*- to the nitro group.
(C) Substitution occurs in ring A, *o*- to the methylene group.
(D) Substitution occurs in ring B, *m*- to the methylene group.
(E) None of the above.

19. Select the structure of the major product in the following reaction.



(A) Ethylbenzene (B) 1-Phenylethanol (C) Acetophenone
(D) 2-Phenylethanal (E) Vinylbenzene

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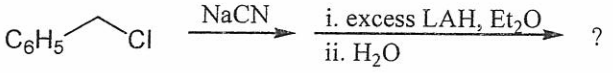
20. Which compound would be formed when 2-methylbutanal is treated with a solution of NaOD in D_2O?

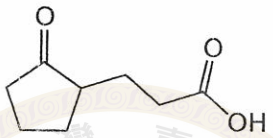
(A) CH_3CH_2CDCHO (CH_3) (B) CH_3CH_2CHCDO (CH_3) (C) $CH_3CHDCHCHO$ (CH_3) (D) CH_2DCH_2CHCHO (CH_3) (E) CH_3CH_2CDCDO (CH_3)

21. What would be the final organic product of the following reaction?



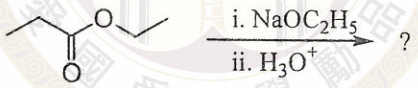
(A) $C_6H_5CH_2CH_2CO_2H$　(B) $C_6H_5CH_2CH_2NH_2$　(C) $C_6H_5CH_2CH(CH_3)CN$
(D) $C_6H_5CH_2CH{=}NH$　(E) $C_6H_5CH_2NH_2$

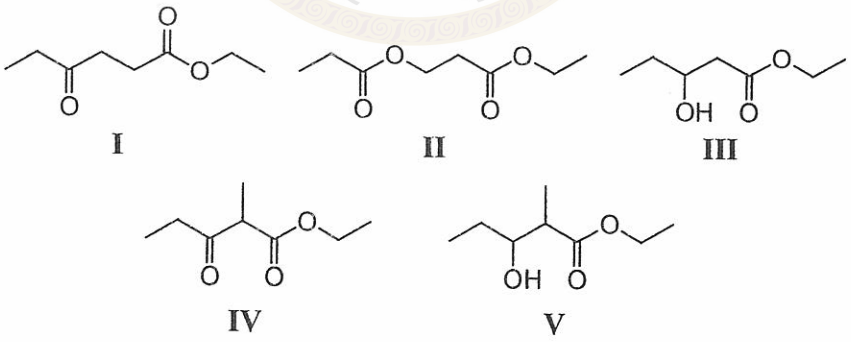
22. Which of the following could be used to synthesize the following substance in good yield?



(A) Cyclopentanone, $ClCH_2CH_2COOH$, $AlCl_3$, heat.
(B) Cyclopentanone, $(CH_3CH_2)_2NH$, HA, $(-H_2O)$; then $BrCH_2CH_2COOC_2H_5$; then OH^-, H_2O, heat; then H_3O^+.
(C) 3-(2-hydroxycyclopentyl)propanal, $KMnO_4$, OH^-, heat; then H_3O^+.
(D) Answers A) and B).
(E) Answers B) and C).

23. What would be the major product of the following reaction?





(A) **I**　(B) **II**　(C) **III**　(D) **IV**　(E) **V**

24. Which reagent will distinguish between $C_6H_5NH_2$ and $(C_6H_5)_2NH$?

(A) HCl (aq)　(B) NaOH (aq)　(C) $C_6H_5SO_2Cl/OH^-$, then H_3O^+
(D) Br_2/CCl_4　(E) $KMnO_4$

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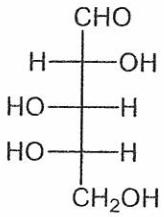
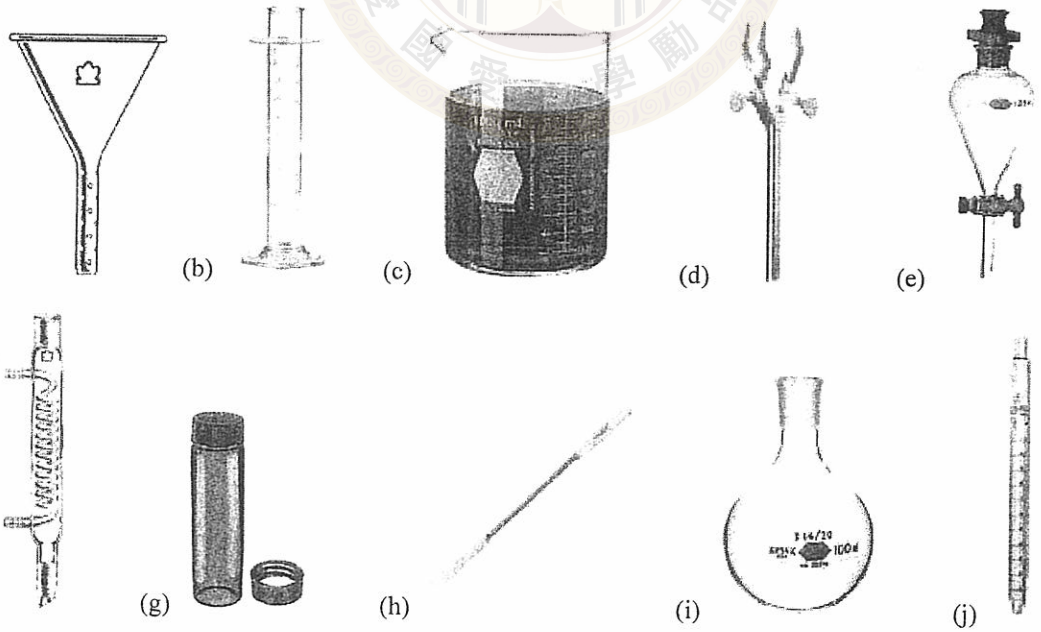
25. What are the correct designations for the stereogenic centers in this aldose?



(A) 2*R*,3*S*,4*R*　(B) 2*R*,3*S*,4*S*　(C) 2*S*,3*R*,4*R*
(D) 2*S*,3*S*,4*R*　(E) 2*R*,3*R*,4*S*

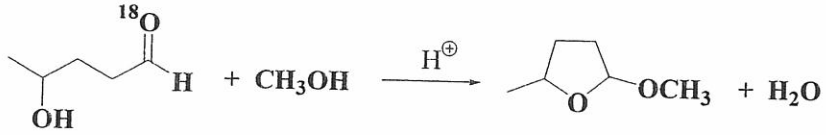
Part II. 問答題 （5 題，50 分）

1. Please name the following items in English. (20 points)



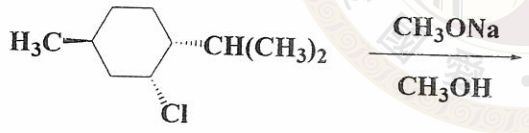
2. Account for the fact that $CH_3CH_2CH_2CH_2Cl$ reacts with 0.01 M NaCN in ethanol to yield primarily $CH_3CH_2CH_2CH_2CN$, whereas under the same condition $(CH_3)_3CCl$ reacts to give primarily $(CH_3)_3COCH_2CH_3$. (8 points)

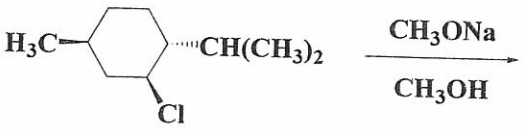
3. Propose a mechanism for the following transformation. If the carbonyl oxygen is enriched with oxygen-18, where would you expect this oxygen label to appear? (8 points)



4. Please briefly describe how you could experimentally determine that *trans*-2-butene is more stable than *cis*-2-butene. (6 points)

5. Which of the following will undergo an elimination reaction more rapidly? Give the structure of the major product(s) and explain your answers. (8 points)





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