

說明：答案一律寫在答案紙並請標明題號依序作答

1. 選擇題 (單選, 共 10 小題 A-J, 每小題 2 分, 答錯不倒扣, 共 20%)

A. The carbohydrate fructose differs from the carbohydrate glucose in which one of the following way?

- a). Fructose has fewer carbons b). Fructose has more carbons
c). Fructose contains a ketone function rather than an aldehyde function
d). The cyclic form of fructose is a derivative of hemiacetal
e). Fructose contains an ester linkage

B. Which is the chemical similarity between cyclohexene and benzene?

- a). Both can react with H_2 b). Both can undergo combustion reactions
c). Both can react with HCl d). Both can react with Br_2
e). All the above statements are correct.

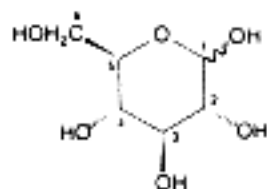
C. Use the hybridization model to build a picture of linear molecule, H-C-H. Which of the following statement is correct?

- a). Bonds to hydrogen are made through overlap of sp^2 and $1s$ orbitals.
b). Carbon uses four bonding electrons in carbon-hydrogen bonds.
c). The $2p_x$ and $2p_y$ orbitals of carbon remain unchanged.
d). Two hybrids formed from $2s \pm 2p_z$ are needed for bonding to two hydrogens.
e). None of the above is correct.

D. Which of the following cycloalkanes has lowest strain energy?

- a). Cyclobutane b). Cyclopentane c). Cyclohexane
d). Cycloheptane e). Cyclooctane

E. For the following compound, which statement is correct?

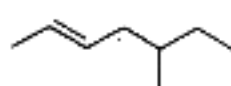


- a). The configuration of C2 is *S* b). The configuration of C4 is *R*
c). C1-OH can be up or down. So there are two structures, which are enantiomers.
d). This compound can be reduced e). None of the above is correct.

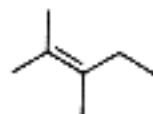
F. For S_N2 reaction, which of the following compounds has higher reactivity when reacting with I^- ?

- a). Cyclopropyl bromide b). Cyclobutyl bromide c). Cyclopentyl bromide
d). Cyclohexyl bromide e). Isopropyl bromide

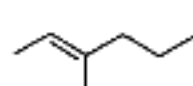
G. Arrange the following alkenes in order of increasing stability.



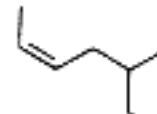
A



B



C

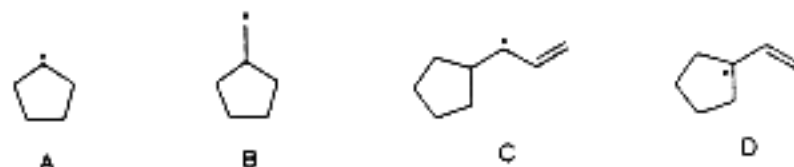


D

- a). $D < A < C < B$ b). $A < B < D < C$ c). $D < C < A < B$
d). $A < D < C < B$ e). None of the above

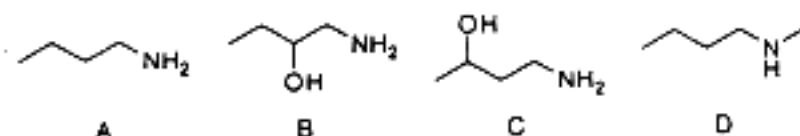
(背面仍有題目, 請繼續作答)

H. Arrange the following species in order of increasing stability.



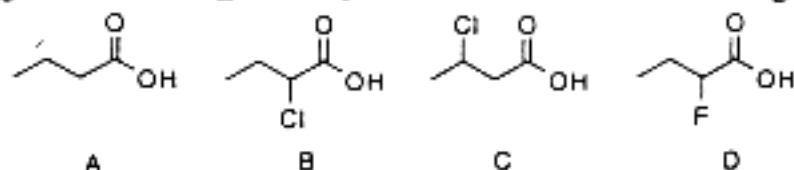
- a). $B < C < A < D$ b). $A < B < C < D$ c). $B < A < C < D$
 d). $A < B < D < C$ e). None of the above

I. Arrange the following in order of increasing basicity.



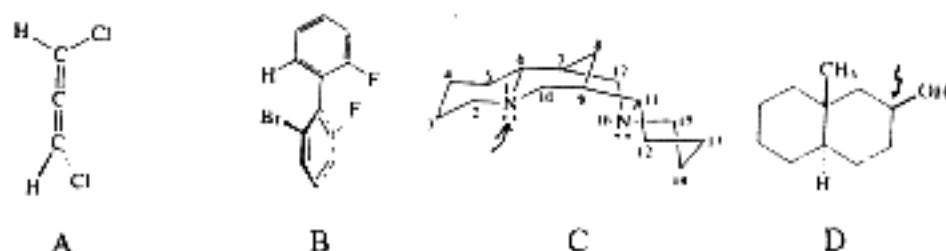
- a). $B < C < A < D$ b). $C < B < A < D$ c). $B < C < D < A$
 d). $A < B < D < C$ e). None of the above

J. Arrange the following carboxylic acids in order of increasing acidity.

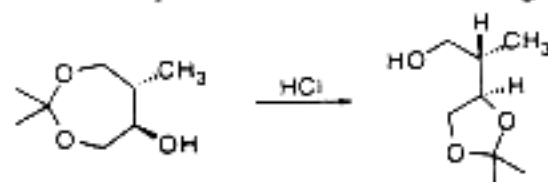


- a). $A < C < B < D$ b). $A < B < C < D$ c). $C < A < B < D$
 d). $A < B < D < C$ e). None of the above

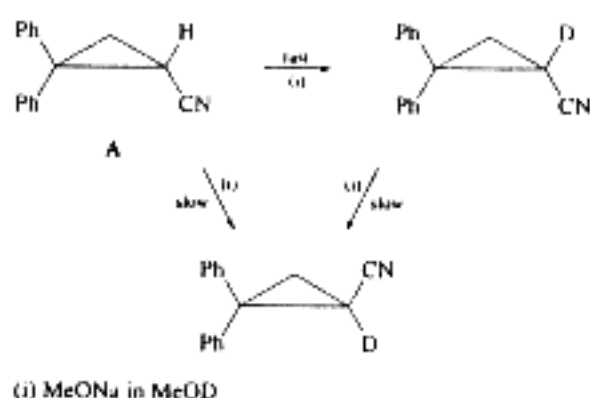
2. When optically active (*S*)-2-bromooctane ($[\alpha] = +39.6^\circ$) was allowed to react with a mixture of water and ethyl alcohol, 2-octanol, with $[\alpha]_{\text{obs}}$ of $+6.0^\circ$, was obtained as the major product. And optically pure (*R*)-2-octanol has a specific rotation of -10.3° . i). What is the optical purity of 2-octanol produced in this reaction? (3%) ii). What is the ratio of two products (*R/S*) in the mixture? (3%) iii). What is the structure of major product? (2%)
3. In the synthesis of cyclohexene from cyclohexanol with an acidic catalyst, it was found that mixing cyclohexanol with phosphoric acid is an exothermic process while the production of cyclohexene is endothermic. i). Please show the reaction mechanism for the synthesis of cyclohexene. (5%) ii). Construct an energy diagram showing the course of reaction. Label the diagram with the starting material, the intermediates, and the product. (6%)
4. a). Give an example (a reaction) to define epimerization. (4%)
 b). Give stereodescriptor to the chiral molecules of compounds A and B and the arrow designated stereogenic center of compounds C and D. (8%)



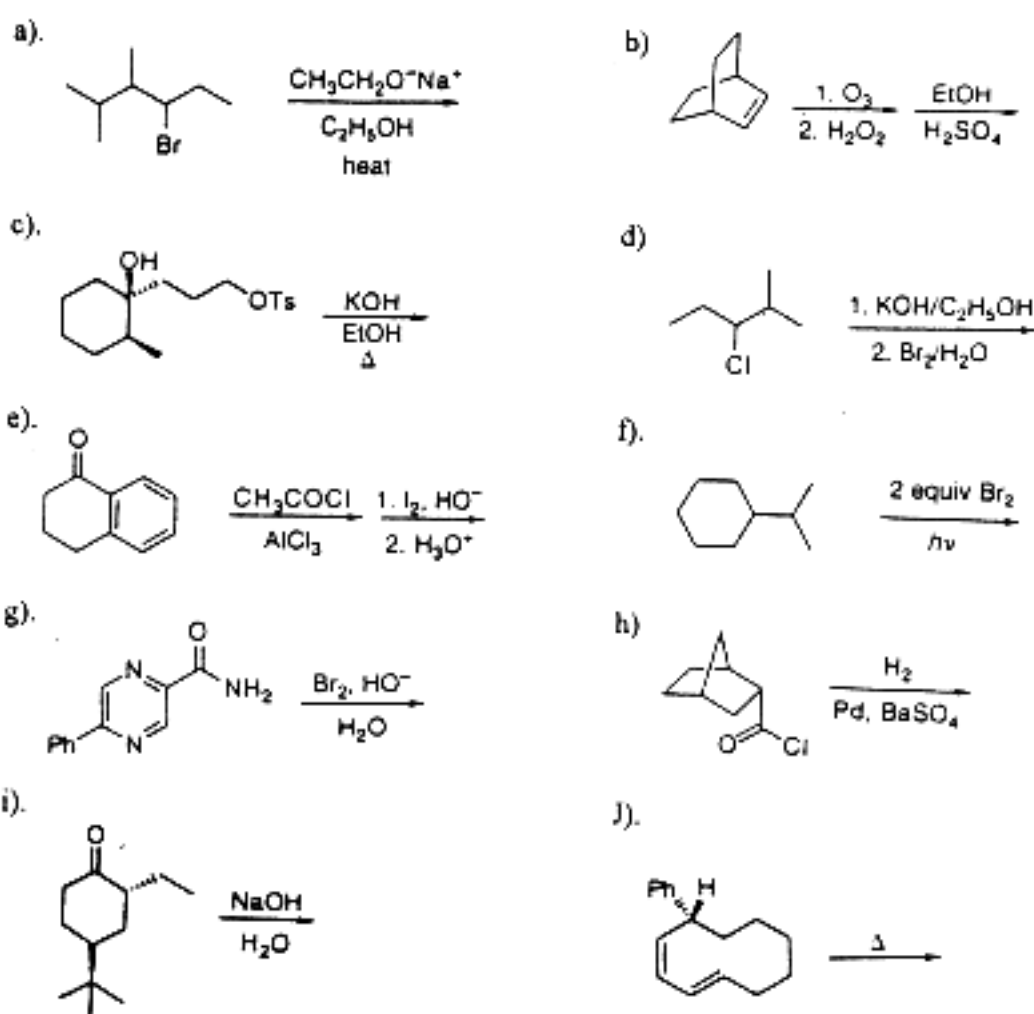
5. Provide a mechanistic explanation for the following rearrangement reaction. (5%)



6. Groups other than the carbonyl group activate adjacent positions such that the protons are easily removed by base. Examples include nitro compounds, sulfones, and nitriles. Thus, the optically active nitrile A would, at the first sight, be expected to racemize when treated with base. However, A undergoes deuterium exchange 4000 times faster than it racemizes when treated with sodium methoxide in deuteriomethanol. Explain why. (6%)



7. Give the product for the following reactions. Be sure to indicate the stereochemistry where necessary. (30%, 3 each)



8. A aromatic compound A was isolated from the bark of the sweet birch (*Betula lenta*). Compound A is soluble in 5% aqueous NaOH solution but not in 5% aqueous NaHCO₃ solution. The spectra of compound A are summarized below. What is the structure of compound A? And account for your answer. Hint: J_{meta} and J_{para} were not observed. The pK_a of phenol is about 10, and that of benzoic acid is about 4.5. (8%)

Mass spectrum: $m/z = 152$ (p, 49%), 121 (29%), 120 (100%), 92 (54%)

IR (neat): 3205 (br), 1675 (s), 1307 (s), 1220 (s), and 757 (s)

¹H NMR (CDCl₃, 300 MHz): 3.92 (s, 3H), 6.85 (t, $J=8$ Hz, 1H), 7.00 (d, $J=8$ Hz, 1H), 7.44 (t, $J=8$ Hz, 1H), 7.83 (d, $J=8$ Hz, 1H), 10.8 (s, 1H)

H-coupled ¹³C NMR (CDCl₃): 52.1 (q), 112.7 (s), 117.7 (d), 119.2 (d), 130.1 (d), 135.7 (d), 162.0 (s), 170.7 (s)