※ 考生請注意：本試題 □可 ☑不可 使用計算機

1-50 (2 points for each; 1-40 are choice questions and wrong answer will deduct 1 point)

1. Which of the following compounds will react most rapidly with HCl?
A. 5-methyl-1-hexene B. 4-methyl-1-hexene
C. E-5-methyl-2-hexene D. E-2-methyl-3-hexene
E. 2-methyl-2-hexene

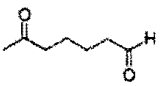
2. Rank the following in order of decreasing acidity.

H_2O CH_3CH_3 NH_3 $CH_2{=}CH_2$ $HC{\equiv}CH$

A **B** **C** **D** **E**

A. **A > E > C > D > B**
B. **A > E > D > B > C**
C. **E > A > C > B > D**
D. **A > C > E > D > B**
E. **E > D > B > A > C**

3. An unknown alkene was treated with ozone followed by CH_3SCH_3 to give the indicated product. The structure of the starting alkene was:

Product = 

A.  B.  C.  D.  E. 

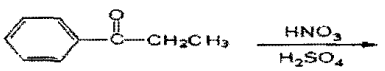
4. Which of the following alkenes has the smallest heat of hydrogenation ($\Delta H°$)?

A.  B.  C.  D.  E. 

5. Which of the following reagents would be suitable for performing the transformation shown below?

A. BH_3, H_2O_2, NaOH
B. CH_3CO_3H
C. CrO_3
D. NBS, H_2O_2
E. OsO_4, pyridine

6. Which of the following best describes the outcome of the following aromatic substitution reaction?



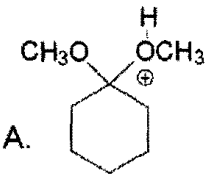
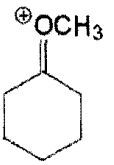
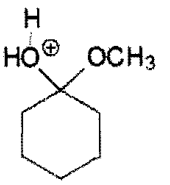
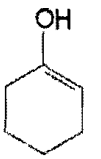
A. Fast reaction, major products ortho and para
B. Fast reaction, major product meta
C. Slow reaction, major products ortho and para
D. Slow reaction, major product meta

(背面仍有題目,請繼續作答)

※ 考生請注意：本試題 □可 ☑不可 使用計算機

7. By what mechanism is an aldehyde converted to its hydrate in an acidic medium?
A. Nucleophilic addition
B. Electrophilic addition
C. Nucleophilic substitution
D. Electrophilic substitution

8. Which species below is NOT an intermediate in the acid-catalyzed hydrolysis of an acetal?

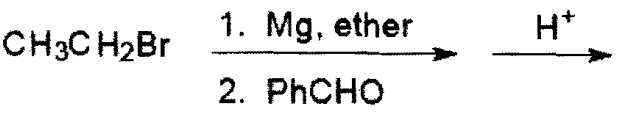
A. 
B. 
C. 
D. 

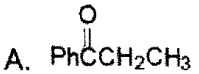
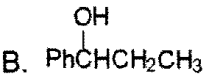
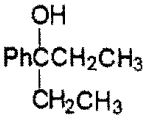
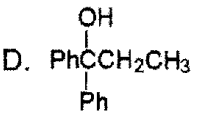
9. Which reagent would react with cyclohexanone to form a carbonyl derivative?
A. H_2N-OH B. $(CH_3)_3N$ C. CH_3CH_2OH, H^+ D. $LiAlH_4$

10. Which reagent would serve to effect the following reaction?

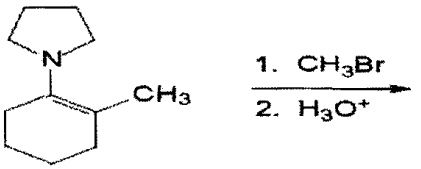
A. CH_3OH, H^+ B. CH_3O^-/CH_3OH C. CF_3CO_3H D. Br_2, OH^-(aq)

11. Determine the product of the following reaction.

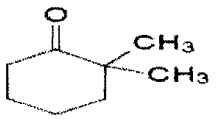


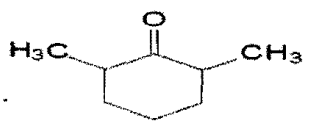
A. 
B. 
C. 
D. 

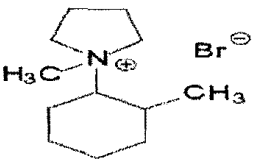
12. Determine the product of the following reaction.

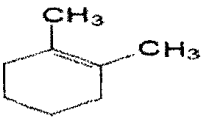


※ 考生請注意：本試題 □可 ☑不可 使用計算機

A. 

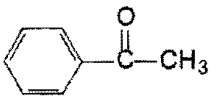
B. 

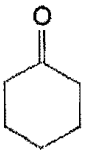
C. 

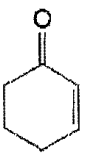
D. 

13. Which of the following compounds would react with HCN in a conjugate addition reaction?

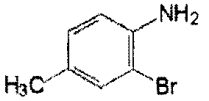
A. 

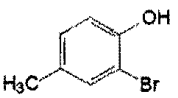
B. 

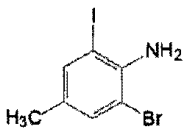
C. 

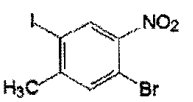
D. 

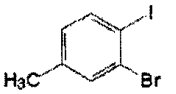
14. Determine the structure of the product when the following compound is treated with nitrous acid (HNO_2) at 5°C, followed by potassium iodide at 25°C.



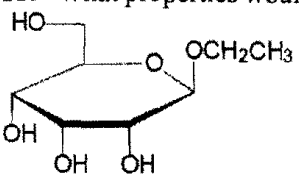
A. 

B. 

C. 

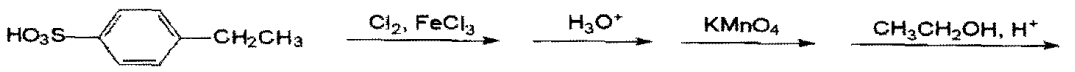
D. 

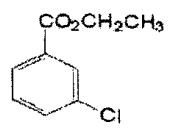
15. What properties would be expected for the following compound?

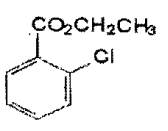


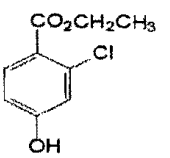
A. Hydrolysis under basic conditions
B. Hydrolysis under acidic conditions
C. Converted to a tetramethyl ether with dimethyl sulfate under basic conditions.
D. Both B and C

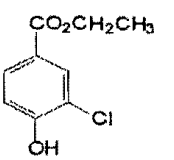
16. Determine the product of the synthetic sequence below.



A. 

B. 

C. 

D. 

17. What is the significance of λmax in UV spectroscopy?
A. λmax is a measure of the length of the carbon chain.

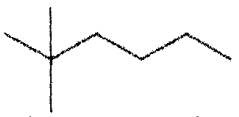
(背面仍有題目,請繼續作答)

※ 考生請注意：本試題 □可 ☑不可 使用計算機

B. λmax is a measure of the length of a conjugated system.
C. λmax is a measure of the number of π electrons in a cyclic polyene.
D. λmax is a measure of the heat of hydrogenation of a conjugate polyene.

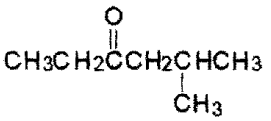
18. Which substituent would be classified as a π electron-donating group?
A. $-CH_3$ B. $-OCH_3$ C. $-CO_2CH_3$ D. $-CONH_2$

19. What species is responsible for the peak at m/z = 57 in the mass spectrum of the following compound?



A. $^{+}C(CH_3)_3$ B. $^{+}CH_2CH_2CH_2CH_3$ C. $\bullet C(CH_3)_3$ D. $\bullet CH_2CH_2CH_2CH_3$

Questions **20– 22** refer to the spectroscopic properties of 5-methyl-3-hexanone, the following structure.

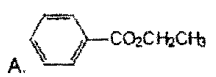


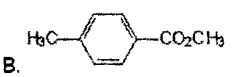
20. Which carbon atom would have the largest chemical shift in its ^{13}C NMR spectrum?
A. C(1) B. C(2) C. C(3) D. C(6)

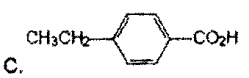
21. Which statement about the spectroscopic properties of 5-methyl-3-hexanone is true?
A. 5-Methyl-3-hexanone will undergo a McLafferty rearrangement in the mass spectrometer.
B. The ^{13}C NMR spectrum of 5-methyl-3-hexanone will consist of seven lines.
C. The methyl group at C(1) will appear as a doublet in the ^{1}H NMR spectrum.
D. The two hydrogens at C(2) will have the smallest chemical shift in the ^{1}H NMR spectrum.

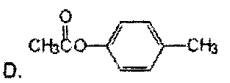
22. Which splitting pattern will be *absent* in the ^{1}H NMR spectrum of 5-methyl-3-hexanone?
A. Singlet B. Doublet C. Triplet D. Quartet

23. The ^{1}H NMR spectrum of an unknown compound, $C_9H_{10}O_2$ is reproduced below. Determine the structure of the unknown compound.
ppm(δ): 2.38 (s, 3H); 3.88 (s, 3H); 7.21 (d, 2 H); 7.92 (d, 2H)

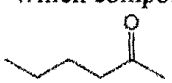

A.


B.

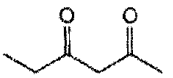

C.

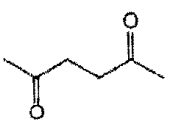

D.

24. Which compound would be the most extensively enolized?

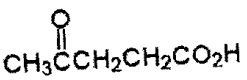
A. 

B. 

C. 

D. 

25. Determine the IUPAC name of the following compound (common name: levulinic acid)



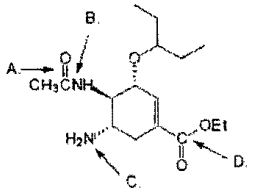
※ 考生請注意：本試題 □可 ☑不可 使用計算機

A. 2-oxopentanoic acid
B. 4-oxopentanoic acid
C. 1-carboxy-4-pentanone
D. 5-carboxy-2-pentanone

26. When carboxylic acid derivatives are arranged in order of *decreasing* reactivity in nucleophilic substitution reactions, which trend is followed?
A. The compounds are arranged in order of increasing C-O bond strength.
B. The compounds are arranged in order of decreasing resonance stabilization.
C. The compounds are arranged in order of increasing electron delocalization.
D. The compounds are arranged in order of increasing water solubility.

27. Which compound would be classified as a primary amine?
A. 1-pentanamine
B. 2-pentanamine
C. *N*-methyl-1-pentanamine
D. Both A and B

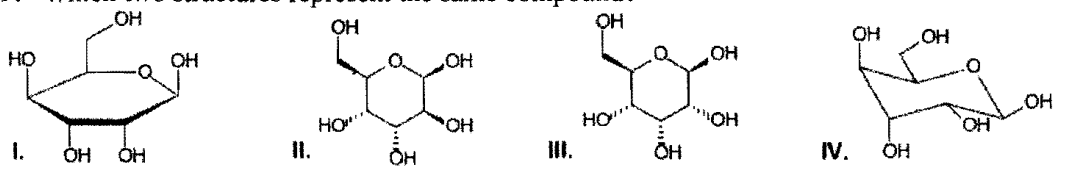
28. The structure of tamiflu, the antiviral drug thought to be effective against the current outbreak of H1N1 flu. Which statement about the properties of tamiflu is true?



tamiflu

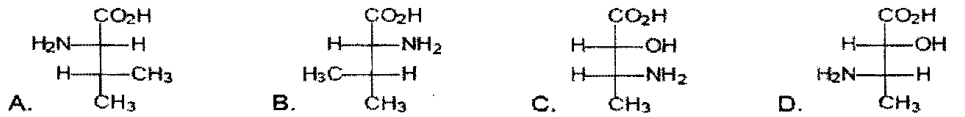
A. The carbon oxygen double bond indicated by A is unusually strong.
B. The nitrogen atom indicated by B is the most basic.
C. The amino group indicated by C is a relatively strong acid.
D. The carbonyl group indicated by D is susceptible to nucleophilic attack under acidic and basic conditions.

29. Which two structures represent the same compound?



A. I and II B. II and III C. III and IV D. IV and I

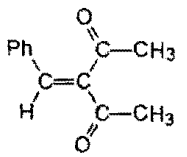
30. Which structure represents a naturally occurring amino acid?

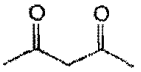


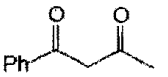
31. What combination of reactants would produce the following compound under basic conditions?

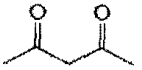
(背面仍有題目,請繼續作答)

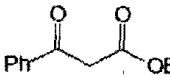
※ 考生請注意：本試題 □可 ☑不可 使用計算機



A.  + PhCHO

B. 

C.  + $PhCO_2Et$

D. 

32. Which species is NOT an intermediate in the Fischer esterification of propanoic acid with ethanol?

A. $CH_3CH_2\overset{\oplus}{O}H_2$ B. $CH_3CH_2\overset{\oplus}{C}(OH)OH$ C. $CH_3CH_2\overset{\oplus}{C}(OH)OCH_2CH_3$ D. $CH_3CH_2C(\overset{\oplus}{O}H_2)(OH)OCH_2CH_3$

33. Determine the products of the following reaction.

$CH_3CH_2C(=O)NHCH_2CH_3 \xrightarrow[H_2O]{\ominus OH,\ heat}$

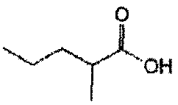
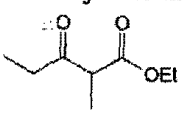
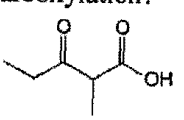
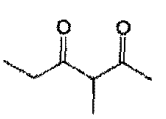
A. $CH_3CH_2CO_2H$ + $CH_3CH_2NH_2$

B. $CH_3CH_2CO_2^{\ominus}$ + $CH_3CH_2NH_2$

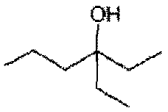
C. $CH_3CH_2CO_2H$ + $CH_3CH_2\overset{\oplus}{N}H_3$

D. $CH_3CH_2CO_2^{\ominus}$ + $CH_3CH_2\overset{\oplus}{N}H_3$

34. Which compound would be subject to thermal decarboxylation?

A.  B.  C.  D. 

35. Which combination of reactants will produce the compound below (after acidification)?



A. $CH_3CH_2CH_2CO_2Et$ + 2 CH_3CH_2MgBr

B. $CH_3CH_2CH_2CHO$ + 2 CH_3CH_2MgBr

C. HCO_2Et + 3 CH_3CH_2MgBr

D. Both A and B

36. Which compound could serve as an ester enolate acceptor in a "crossed Claisen" reaction?

A. $(CH_3)_3CCO_2Et$ B. $CH_3CH_2CO_2Et$ C. $CH_3CH_2\overset{O}{\overset{\|}{C}}CH_2CH_3$ D. CH_3CH_2CHO

37. Which of the reactions below would NOT produce *n*-butylamine ($CH_3CH_2CH_2CH_2NH_2$)?

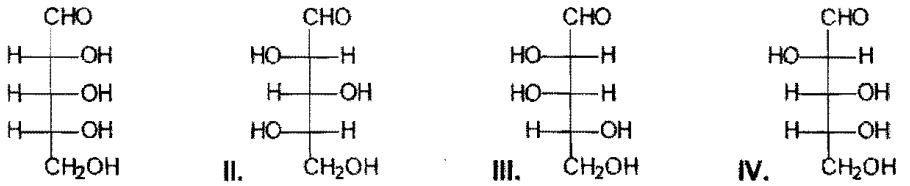
※ 考生請注意：本試題 □可 ☑不可 使用計算機

A. $CH_3CH_2CH_2C{\equiv}N \xrightarrow{LiAlH_4}$ B. $CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}NH_2 \xrightarrow{Br_2,\ OH^-(aq)}$

C. $CH_3CH_2CH_2\overset{O}{\overset{\|}{C}}NH_2 \xrightarrow{LiAlH_4}$ D. $CH_3CH_2CH_2CH_2N_3 \xrightarrow{LiAlH_4}$

38. What are the products of the periodic acid oxidation of a typical aldopentose?
A. 2 HCO_2H and 3 H_2CO
B. 3 HCO_2H and 2 H_2CO
C. 4 HCO_2H and H_2CO
D. 5 HCO_2H

39. Which two monosaccharides would form the same phenylosazone derivative when treated with excess phenylhydrazine ($PhNHNH_2$)?

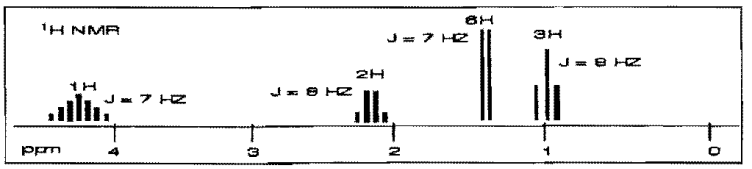


A. I and II B. II and III C. III and IV D. IV and I

40. For which compound would the ^1H NMR spectrum consist of a singlet, a doublet, and a triplet?
A. $CH_3OCH_2CH_2Br$
B. $CH_3CH_2OCH_2Br$
C. $CH_3CH_2OCHBr_2$
D. $BrCH_2CH(OCH_3)_2$

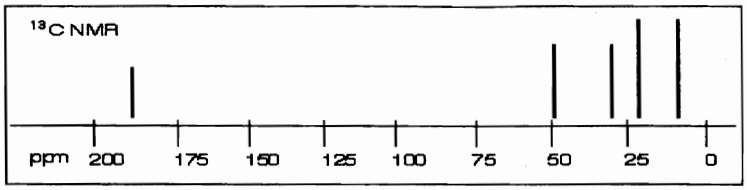
41. Identify the unknown compound that has all the following characteristics. (2 points)
Molecular formula: $C_{10}H_{14}$
^{13}C NMR shows only four peaks: 20, 40, 120, 150 ppm
^1H NMR: 1.0 ppm, 6H triplet
2.4 ppm, 4H quartet
7.0 ppm, 4H, singlet

42. Identify the unknown compound that has all the following characteristics. (2 points)
Molecular formula: $C_6H_{12}O_2$
IR: peak at 1735 cm^{-1}
NMR:

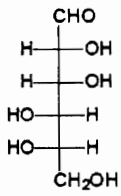


(背面仍有題目,請繼續作答)

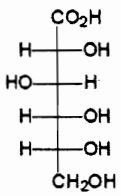
※ 考生請注意：本試題 □可 ☑不可 使用計算機



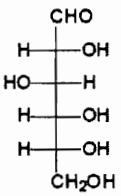
43-50. Monosaccharides can be depicted by a variety of different structural representations. The structures of eight monosaccharides are shown in the following figure. Match each of the descriptions that follow with letter of the corresponding structural formula. Note that a letter may be used more than once or not at all. (16 points)



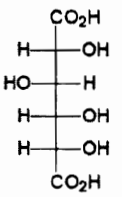
A



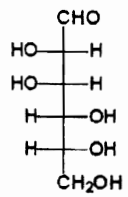
B



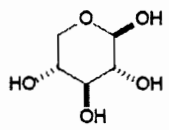
C



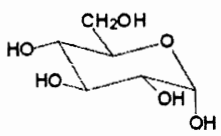
D



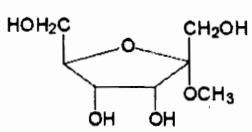
E



F



G



H

43. Which one is a glycoside?

44. Which one is an aldonic acid?

45. Which one is furanose?

46. Which one is an L-sugar?

47. Which one is an aldopentose?

48. Which is a pair of enantiomers?

49. Which are two representation of D-glucose?

50. Which are two compounds that the same phenylosazone derivatives?