國立中興大學115學年度

學士後醫學系公費生招生考試

化學科試題

考試時間：100分鐘

考試開始鈴響前，不得翻閱試題，且不得書寫、劃記、作答!
本考試不得使用計算機

考生請注意：

一、考生應確實關閉行動電話(或取出電池)及手錶之鬧鈴設定；除准考證及考試必需用品外，所有物品(含行動電話、穿戴式裝置等)均應立即放置於臨時置物區，不得發出聲響或有影響試場秩序之情形。

二、請確認抽屜中、桌椅下、座位旁均無其他非必要用品。如有任何問題請立即舉手反映。

三、坐定後，雙手離開桌面，請核對並確認准考證、座位標籤、及答案卡上之准考證號碼是否完全相同。如有錯誤，應立即舉手請監試人員處理。

四、考生應試時不得飲食、飲水、抽菸、嚼食口香糖。

五、答案卡劃記以2B鉛筆為佳，劃記時要粗黑、清晰，劃滿作答格，不可出格，不得折損答案卡，修正作答以軟性橡皮擦擦拭乾淨，且不得使用修正液(帶)修正，未遵照正確作答方式而致機器無法正確辨識答案者，考生自行負責，不得以任何理由補救。答案寫在試題紙上者不予計分。

六、本試題必須與答案卡一併繳回，不得攜出試場。

第1題至第50題，1題2分，共100分
答錯1題倒扣0.25分；未作答，不給分亦不扣分。
倒扣至零分為止。

1. What is the bond order of the carbon-carbon bonds in benzene?
   (A) 2
   (B) 1.5
   (C) 3
   (D) 0.5
   (E) 1

2. 1-Methylcyclopentanol is classified as _____.
   (A) an enol
   (B) a secondary alcohol
   (C) a tertiary alcohol
   (D) a phenol
   (E) a primary alcohol

3. The Hofmann elimination proceeds via a(n) _____ pathway.
   (A) E1
   (B) E2
   (C) S_N2
   (D) S_N1
   (E) none of the above

4. Which of the following yields a primary alcohol upon reduction?
   (A) a ketone
   (B) an alkene
   (C) an amine
   (D) an aldehyde
   (E) an ether

5. The following two reactions are important in the blast furnace production of iron metal from iron ore (Fe_2O_3):

   $$2C(s) + O_2(g) \rightarrow 2CO(g)$$

   $$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

   Using these balanced reactions, how many moles of O_2 are required for the production of 2.51 kg of Fe? (Molecular weight of Fe = 55.85 g/mol)
   (A) 33.7 moles
   (B) 15.0 moles
   (C) 135 moles
   (D) 44.9 moles
   (E) 1.88 moles

6. Esters and amides are most easily made by nucleophilic acyl substitution reactions on _____.
   (A) acid chlorides
   (B) carboxylic acids
   (C) acid anhydrides
   (D) carboxylates
   (E) alcohols

7. Which of the following is also an acceptable name for 3-nitrophenol?
(A) 3-cresol
(B) hydroquinone
(C) *m*-nitrophenol
(D) *p*-nitrophenol
(E) *o*-nitrophenol

8. Consider the fermentation reaction of glucose:

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

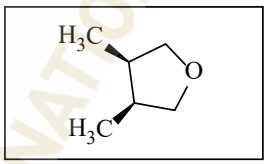
A 1.00-mole sample of $C_6H_{12}O_6$ was placed in a vat with 100 g of yeast. If 48.6 grams of C_2H_5OH was obtained, what was the percent yield of C_2H_5OH?
(A) 52.7 %
(B) 26.4 %
(C) 100 %
(D) 48.6 %
(E) None of these

9. Which of the following solvents could be described as polar and protic?
(A) 18-crown-6
(B) ethanol
(C) acetone
(D) dimethylformamide
(E) acetonitrile

10. In which of the following compounds does N have its maximum oxidation state?
(A) NH_3
(B) N_2O
(C) N_2
(D) $NaNO_3$
(E) HN_3

11. The RNA backbone is linked through a phosphate group. What type of bonding occurs between two consecutive nucleotides in RNA?
(A) Ester
(B) Amide
(C) Hydrogen
(D) Ionic
(E) Hydrophobic

12. How many peaks appear in the proton spin decoupled ^{13}C NMR spectrum of the compound below?

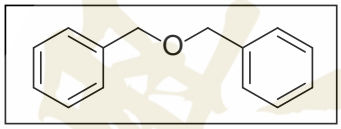


(A) 2
(B) 3
(C) 4
(D) 5
(E) 6

13. UV spectroscopy measures the energy required to promote an electron from the _____ molecular orbital to the _____ molecular orbital.
(A) lowest occupied, highest unoccupied
(B) lowest occupied, lowest unoccupied
(C) highest occupied, highest unoccupied
(D) highest occupied, lowest unoccupied
(E) None of the above

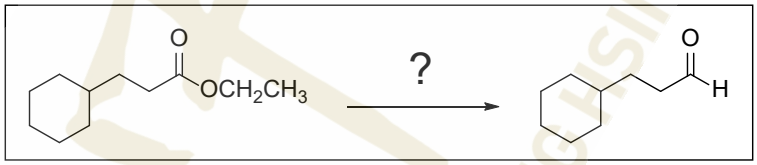
14. When pent-1-ene is treated with mercury(II) acetate in methanol and the resulting product is reacted with $NaBH_4$, what is the primary organic compound which results?
(A) 3-ethoxypentane
(B) 1-methoxypentane
(C) 2-ethoxypentane
(D) 2-methoxypentane
(E) 1-ethoxypentane

15. Provide an acceptable name for the compound below.



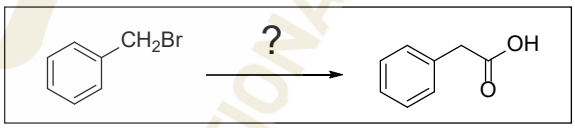
(A) 1,3-diphenyl-3-oxypropane
(B) phenoxyphenylmethane
(C) diphenyl ether
(D) dibenzyl ether
(E) dibenzyl acetal

16. How would you perform the following transformation?



(A) $LiAlH_4$
(B) 1. $SOCl_2$ / 2. $LiAlH(O\text{-}t\text{-}Bu)_3$
(C) $NaBH_4$
(D) 1. DIBAL-H / 2. H_2O
(E) 1. $LiAlH_4$ / 2. concentrated KMO_4

17. What is the best way to perform the transformation shown below?



(A) 1. NaCN / 2. H_3O^+
(B) 1. Mg / 2. CO / 3. H_3O^+
(C) concentrated $KMnO_4$
(D) 1. NaN_3 / 2. H_3O^+
(E) Both A and B would work

18. Which of the following molecules has a characteristic stretch at 3300 cm^{-1}?
(A) $(CH_3)_2CHCO_2CH_3$
(B) $(CH_3)_2CHCH_2N(CH_3)_2$
(C) $(CH_3)_3CH$
(D) $(CH_3)_2CHCH{=}CH_2$
(E) $(CH_3)_2CHC{\equiv}CH$

19. What type of carbon environment does not generate a signal in the DEPT-90 spectrum and gives a positive peak in the DEPT-135 spectrum?
(A) methine
(B) methylene
(C) quaternary
(D) methyl
(E) carbonyl

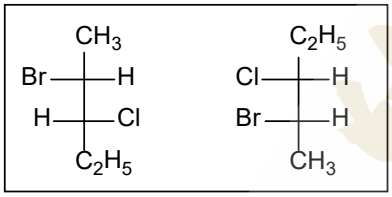
20. An NMR spectrometer that operates at a frequency of 60 MHz for ^{13}C NMR spectra, operates at what frequency for ^{1}H NMR spectra?
(A) 60 MHz
(B) 15 MHz
(C) 120 MHz
(D) 240 MHz
(E) 30 MHz

21. If a mixture contains 75% of one compound and 25% of its enantiomer, what is the *e.e.* of the mixture?
(A) 100
(B) 75
(C) 3
(D) 50
(E) 25

22. Consider the constitutional isomers 2-methylbut-1-ene, 2-methylbut-2-ene, and 3-methylbut-1-ene. When each of these alkenes is subjected to catalytic hydrogenation (H_2, Pt), a single product results. Which of the following best describes the structural relationship among these products?
(A) The products are diastereomers.
(B) The products are identical.
(C) The products are constitutional isomers.
(D) The products are enantiomers.
(E) The products are cis-trans isomers.

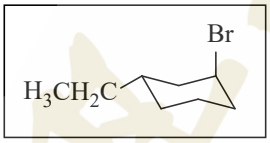
23. How many elements of unsaturation are implied by the molecular formula $C_8H_{11}N$?
(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

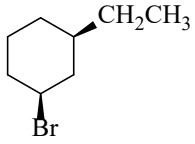
24. Which of the following terms best describes the stereochemical relationship of the two compounds shown below in Fischer notation?

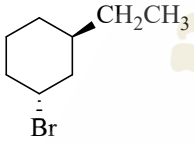


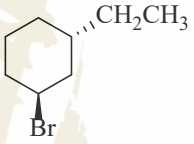
(A) Diastereomers
(B) cis/trans – isomers
(C) enantiomers
(D) constitutional isomers
(E) meso - same structure

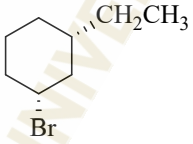
25. Which line-angle formula corresponds to the chair conformation shown below?



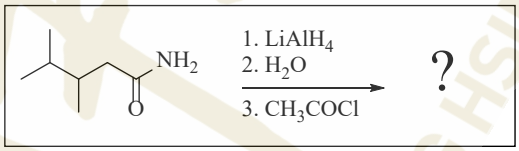
(A) 

(B) 

(C) 

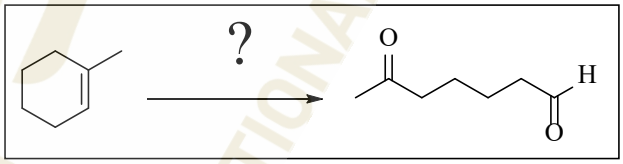
(D) 

26. Predict the major organic product from the following reaction.



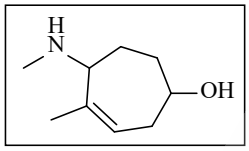
(A) 2° amide
(B) ester
(C) carboxylic acid
(D) nitrile
(E) aldehyde

27. Show how you would perform the following synthesis.



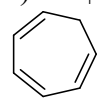
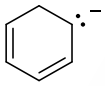
(A) 1. mCPBA / 2. Potassium dichromate
(B) OsO_4
(C) $KMnO_4$, cold. Basic
(D) 1. O_3 / 2. $(CH_3)_2S$
(E) H_2O_2

28. Identify the correct name for the following structure.



(A) 4-hydroxy-7,*N*-dimethylcyclohept-6-enamine
(B) 5-hydroxy-2,*N*-dimethylcyclohept-2-enamine
(C) 4-methyl-5-(methylamino)cyclohept-3-enol
(D) 5-methyl-4-(methylamino)cyclohept-5-enol
(E) 4-methyl-5-(methylamino)cyclohept-3-en-1-one

29. Which of the following structures is aromatic?

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

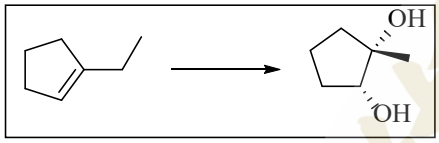
30. Acid chlorides can be prepared from carboxylic acids by treatment with _____.
(A) $(COCl)_2$
(B) $SOCl_2$
(C) KCl
(D) Both A and B
(E) Both B and C

31. By what mechanism does cyclohexanol react when treated in sulfuric acid and what compound results?
(A) E2; methoxycyclohexane
(B) E1; cyclohexene
(C) S_N1; methoxycyclohexane
(D) E2; cyclohexene
(E) E1; methoxycyclohexane

32. Which of the following is transition metal?
(A) Sodium
(B) Potassium
(C) Copper
(D) Silicon

33. What is the major organic product that results when 1-heptyne is treated with 2 equivalents of HBr?
(A) 2,2-dibromoheptane
(B) 1,2-dibromoheptane
(C) 2,3-dibromo-1-heptene
(D) 2,3-dibromo-2-heptene
(E) 1,1-dibromoheptane

34. Provide the reagents necessary to complete the following transformation.



(A) 1. CH_3CO_3H / 2. H^+, H_2O
(B) H_2O, H_2SO_4
(C) CH_3CO_3H
(D) OsO_4, H_2O_2
(E) 1. BH_3·THF / 2. H_2O_2, HO^-

35. Which of the following additions to alkenes occur(s) specifically in an *syn* fashion?
(A) addition of H_2
(B) hydroboration
(C) dihydroxylation using OsO_4, H_2O_2
(D) addition of HCl
(E) A, B and C

36. What is the correct name for the structure of coordination number 6?
(A) Tetrahedral
(B) Octahedral
(C) Square planar
(D) Linea

37. Which of the following has the highest melting temperature?
(A) H_2O
(B) CO_2
(C) LiF
(D) C_{60}

38. What is the oxidation number of manganese in $K_4[Mn(CN)_6]$?
(A) 2+
(B) 3+
(C) 4+
(D) 6+

39. Which of the following metal ions has a d^8 electron configuration?
(A) Ni^{2+}
(B) Zn^{2+}
(C) Cr^{3+}
(D) Cu^+

40. Which of the following is polar molecule?
(A) H_2
(B) He
(C) CO_2
(D) H_2O

41. Using the following data reactions:
$H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)}$　$\Delta H° = -103$ kJ
$H_{2(g)} \rightarrow 2H_{(g)}$　$\Delta H° = 432$ kJ
$Br_{2(g)} \rightarrow 2Br_{(g)}$　$\Delta H° = 193$ kJ
calculate the energy of an H-Br bond.
(A) 728 kJ
(B) 261 kJ
(C) 364 kJ
(D) 522 kJ
(E) 182 kJ

42. What type of structure does the $XeOF_2$ molecule have?
(A) Trigonal pyramid
(B) Tetrahedral
(C) T-shaped
(D) Trigonal planar
(E) Bent

43. How many electrons are involved in π bonding in benzene, C_6H_6?
(A) 3
(B) 12
(C) 18
(D) 6
(E) 10

44. An element with the electron configuration [Xe] $6s^2 4f^{14} 5d^7$ would belong to which class on the periodic table?
(A) transition elements
(B) halogens
(C) rare earth elements
(D) alkaline earth elements

45. For the reaction $4FeCl_2(aq) + 3O_2(g) \rightarrow 2Fe_2O_3(s) + 4Cl_2(g)$, what volume of a 0.620 M solution of $FeCl_2$ is required to react completely with 7.26×10^{21} molecules of O_2?
(A) 6.45×10^3 mL
(B) 9.97 mL
(C) 14.6 mL
(D) 25.9 mL
(E) 5.61 mL

46. The calibration points for the linear Reaumur scale are the usual melting point of ice and boiling point of water, which are assigned the values 0°R and 80°R, respectively. The boiling point of benzene is 80.1°F. What is this temperature in °R?
(A) 160.1°R
(B) 49.8 °R
(C) 26.7 °R
(D) 212.2 °R
(E) 21.4 °R

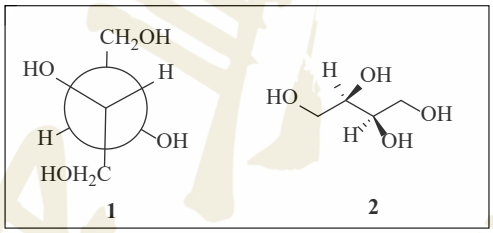
47. Relative abundance is the unit along the y-axis in a mass spectrum. What are the units on the x-axis?
(A) mass (*m*)
(B) frequency (*v*)
(C) molecular weight (*amu*)
(D) mass/charge (*m/z*)
(E) boiling point (*b.p.*)

48. Consider the reaction 3A + B + C → D + E where the rate law is defined as

$$-\frac{\triangle[A]}{\triangle t}=k[A]^2[B][C]$$

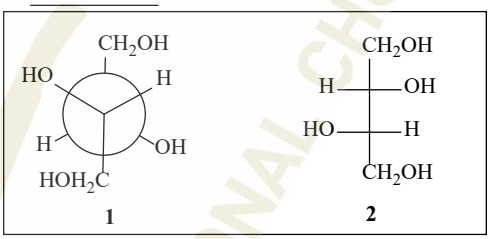
An experiment is carried out where $[B]_0 = [C]_0 = 1.00$ M and $[A]_0 = 1.00 \times 10^{-4}$ M. After 3.00 minutes, [A] $= 3.26 \times 10^{-5}$ M and $\frac{1}{[A]} = 3.067 \times 10^4$. The value of k is :
(A) 6.23×10^{-3} $L^3/mol^3 \cdot s$
(B) 3.26×10^{-5} $L^3/mol^3 \cdot s$
(C) 1.15×10^{2} $L^3/mol^3 \cdot s$
(D) 1.00×10^{8} $L^3/mol^3 \cdot s$
(E) None of these

49. The relationship between 1 and 2 is: _____.



(A) constitutional isomers
(B) same compound
(C) enantiomers
(D) diastereomers
(E) none of above

50. The relationship between 1 and 2 is: _____.



(A) constitutional isomers
(B) same compound
(C) diastereomers
(D) enantiomers
(E) none of above