

# 國立中山大學 113 學年度 碩士班暨碩士在職專班招生考試試題

科目名稱：有機化學及無機化學【化學系碩士班】

## — 作答注意事項 —

考試時間：100 分鐘

- 考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- 答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以 2B 鉛筆劃記，不可使用修正液（帶）塗改，未使用 2B 鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- 試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。
- 試題採雙面列印，考生應注意試題頁數確實作答。
- 違規者依本校招生考試試場規則及違規處理辦法處理。

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題號：422001

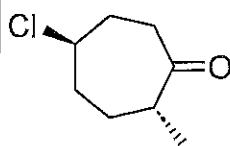
※本科目依簡章規定「不可以」使用計算機(混合題)

共 8 頁第 1 頁

## 一、選擇題 (2% × 43 = 86%)

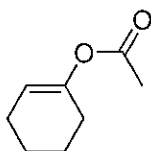
說明：全部單選，每題兩分，答錯不倒扣。

1. What is the correct IUPAC name for the following compound?

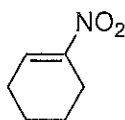


- (A) (2*R*,5*R*)-5-chloro-2-methylcycloheptan-1-one  
 (B) (2*S*,5*R*)-5-chloro-2-methylcycloheptan-1-one  
 (C) (2*R*,5*R*)-5-chloro-2-methylcyclohexan-1-one  
 (D) (1*R*,5*R*)-1-chloro-5-methylcycloheptan-3-one  
 (E) (1*R*,4*R*)-4-chloro-1-methylcycloheptan-7-one

2. Predict and arrange the reactivity of the following compounds in ascending order when reacting with HBr.



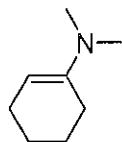
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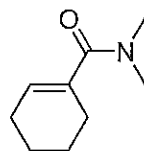
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3



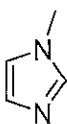
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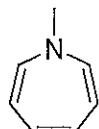
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- (A) 2 < 3 < 5 < 1 < 4  
 (B) 5 < 3 < 2 < 4 < 1  
 (C) 1 < 2 < 5 < 3 < 4  
 (D) 4 < 1 < 3 < 5 < 2  
 (E) 2 < 5 < 3 < 1 < 4

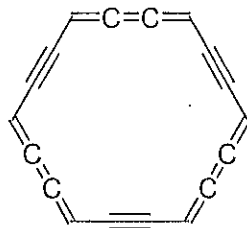
3. Which of the following structures, if flat, can be considered aromatic?



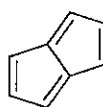
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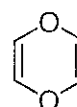
2



3



4



5

- (A) 1 only.  
 (B) 3 and 5 only.  
 (C) 2 and 4 only.  
 (D) 1 and 3 only.  
 (E) None of the above.

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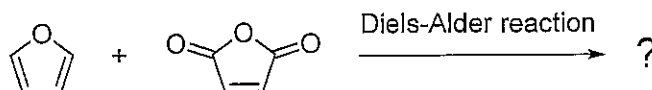
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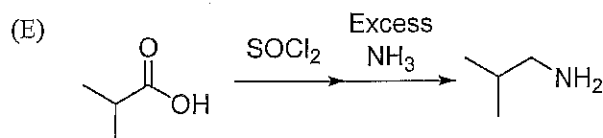
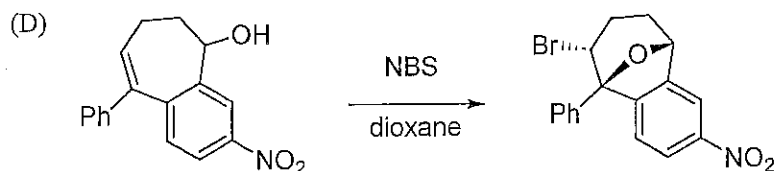
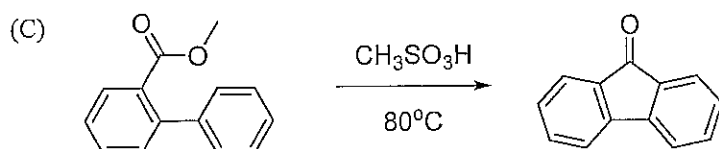
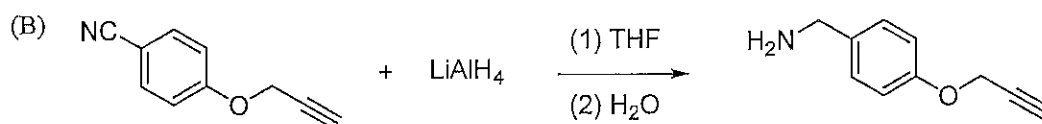
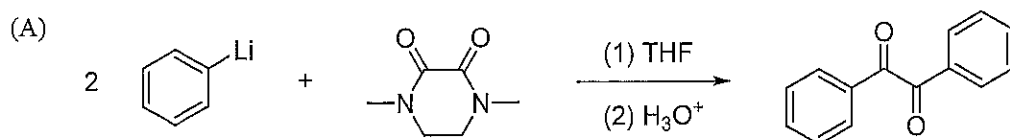
共 8 頁 第 2 頁

4. Which of the following is a correct Diels-Alder reaction product of the following reaction?



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

5. Which of the following reaction will NOT give the product as shown?



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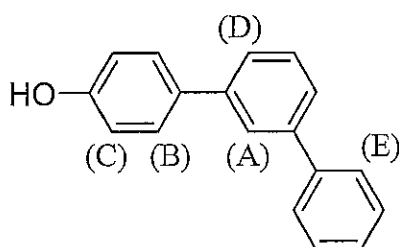
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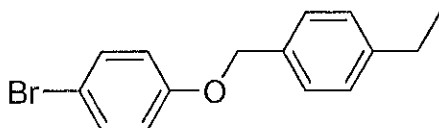
共 8 頁第 3 頁

6. Consider a system in which an ester is hydrolyzed in a base catalyzed hydrolysis using potassium hydroxide as the base. After the reaction, what will happen theoretically concerning the acidity of the reaction mixture when compared to the beginning of the reaction?
- (A) The mixture will become more basic compared to the beginning.  
 (B) The mixture will become more acidic compared to the beginning.  
 (C) The acidity of the reaction mixture will not change.  
 (D) The concept of acidity cannot be applied to organic system.  
 (E) The exact situations depend on the actual structure of the ester.

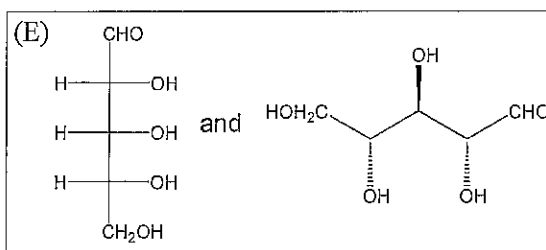
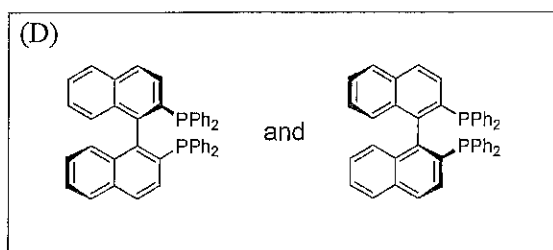
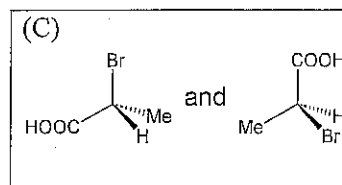
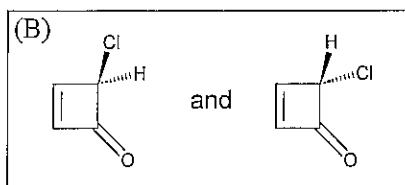
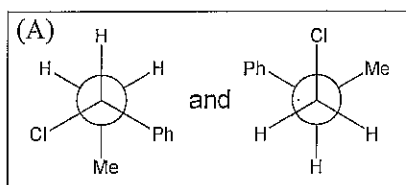
7. Which of the following position is the most reactive towards electrophilic aromatic substitution?



8. Describe the number of signals and their splitting in the  $^1\text{H}$  NMR of the following compound:



- (A) 7 signals: 1 singlet, 2 doublets, 1 triplet, 3 quartet  
 (B) 6 signals: 1 singlet, 3 doublets, 1 triplet, 1 quartet  
 (C) 7 signals: 4 doublets, 2 triplet, 1 quartet  
 (D) 7 signals: 1 singlet, 4 doublets, 1 triplet, 1 quartet  
 (E) 8 signals: 2 singlet, 4 doublets, 1 triplet, 1 quartet
9. Which of the following pair of structures represent an identical compound?



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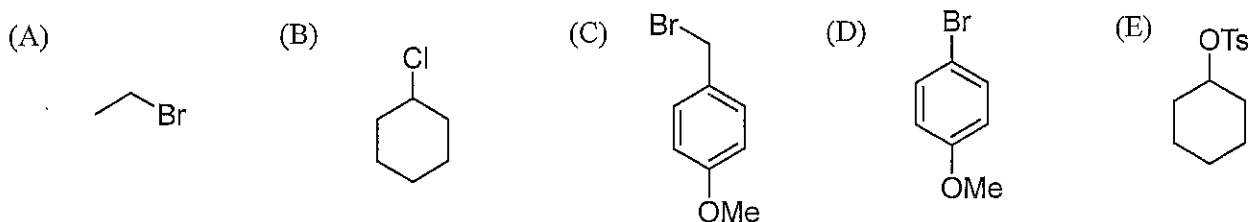
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共 8 頁第 4 頁

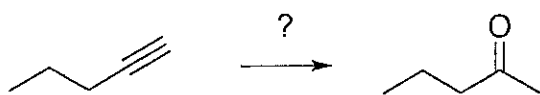
10. Which of the following solvent is the most soluble in water?

- (A) hexanoic acid
- (B) dichloromethane
- (C) dimethylformamide
- (D) 1-butanol
- (E) ethyl acetate

11. Which of the following compound is the most reactive in an  $S_N1$  reaction?



12. Which of the following reaction conditions will give the desire product as shown?

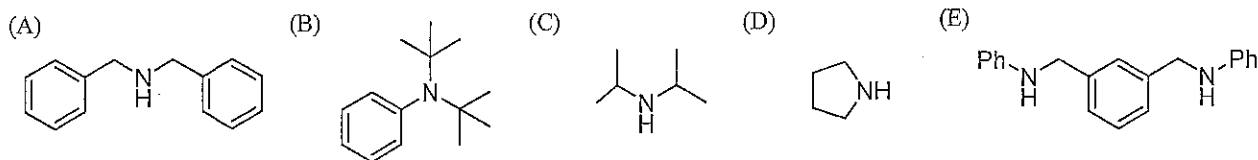


Reaction conditions:

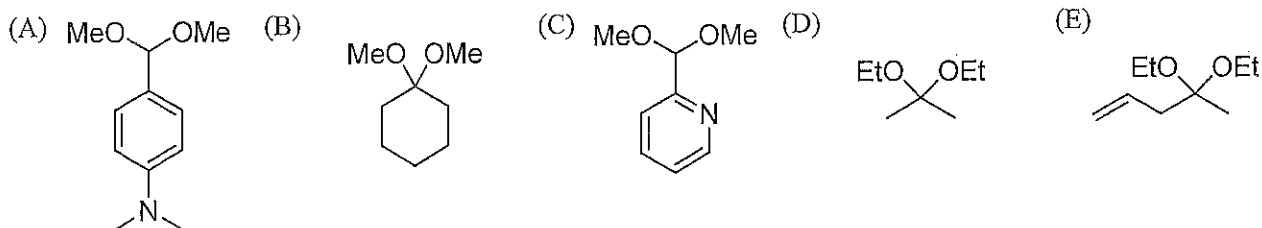
- (1)  $O_3$
- (2)  $H_3O^+$
- (3) Excess HBr, then excess KOH
- (4) BuLi, then  $H_2O$

- (A) (1) and (2) only
- (B) (2) and (3) only
- (C) (2), (3) and (4) only
- (D) All of the above
- (E) None of the above

13. Which of the following amine CANNOT be synthesized by reductive amination?



14. Which of the following acetal will react the fastest in acid-catalyzed hydrolysis?



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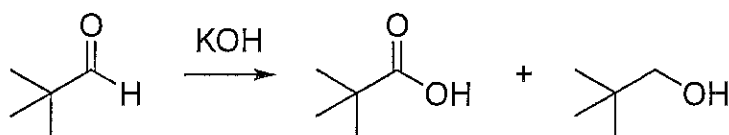
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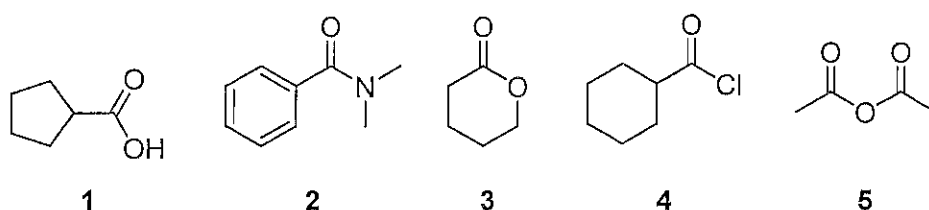
共 8 頁第 5 頁

15. Which of the following compounds is the oxidant in the reaction below?



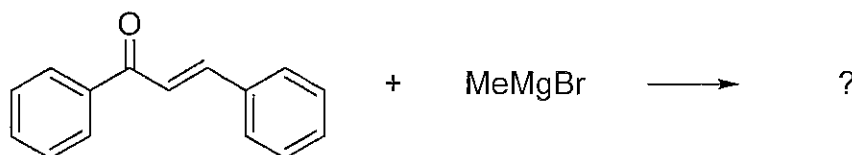
- (A) (B) (C) KOH (D) oxygen in air (E)

16. Rank the reactivity of the following compounds towards nucleophilic substitution of carboxylic acid derivative in increasing order (least to most).



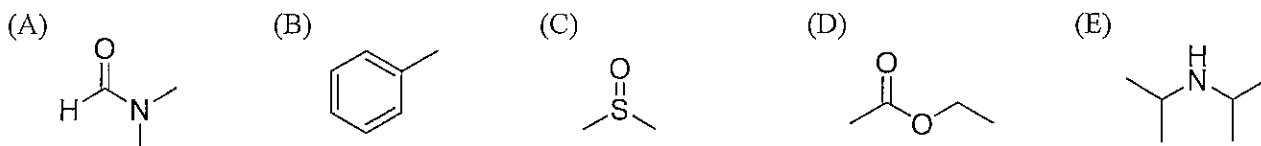
- (A) 2 < 3 < 5 < 1 < 4  
 (B) 5 < 3 < 2 < 4 < 1  
 (C) 1 < 2 < 5 < 3 < 4  
 (D) 1 < 2 < 3 < 5 < 4  
 (E) 2 < 5 < 3 < 1 < 4

17. Which of the following compound is most likely to be the major product of the following reaction?



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

18. Which of the following solvent is a protic solvent?



19. Which of the following description about  $S_N2$  reaction is incorrect?

- (A) The rate of the reaction is second order.  
 (B) Inversion of configuration at the reacting center will occur.  
 (C) There is no intermediate in an  $S_N2$  reaction.  
 (D) Alkyl fluoride is very reactive in  $S_N2$  reaction.  
 (E) In  $S_N2$  reaction, using polar aprotic solvents will give a faster reaction rate compare to polar protic solvents.

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20. Which of the following statements is correct?
- (A) A chiral compound will always react to give a chiral product.  
(B) The most stable conformation of *tert*-butylcyclohexane is with the *tert*-butyl group at the axial position.  
(C) Aryl amines can be synthesized by reduction of nitroarenes.  
(D) The Diels-Alder reaction involves rearrangement of electrons between the two HOMOs of the two reactants.  
(E) A hard nucleophile will prefer to react with an  $\alpha,\beta$ -unsaturated carbonyl compound in 1,4-addition instead of 1,2-addition.
21. Which of the following has the smallest radius?  
(A)  $\text{Ti}^+$  (B)  $\text{Ti}^{2+}$  (C)  $\text{Ti}^{3+}$  (D)  $\text{Ti}^{4+}$  (E) all of the above
22. Which of the following is not an inorganic compound?  
(A)  $\text{BeH}_2$  (B)  $\text{BH}_3$  (C)  $\text{CH}_4$  (D)  $\text{NH}_3$  (E)  $\text{H}_2\text{O}$
23. Which of the following is an organometallic compound?  
(A)  $[\text{HgMe}]^+$  (B)  $\text{NaCl}$  (C)  $\text{PH}_3$  (D)  $\text{Ti}(\text{NMe}_2)_4$  (E)  $\text{Pd}(\text{OAc})_2$
24. Which of the following has the largest electronegativity?  
(A) B (B) C (C) N (D) O (E) F
25. The  $E/R_H$  value for an electron at  $n = 1$  in a  $\text{He}^+$  cation, where  $E =$  energy,  $R_H =$  Rydberg constant = 13.61 eV,  $n =$  principal quantum number, is  
(A) -1 (B) -2 (C) -3 (D) -4 (E) none of the above
26. Among the following compounds, which is not isoelectronic with the others?  
(A)  $\text{BH}_3$  (B)  $\text{CH}_4$  (C)  $\text{NH}_3$  (D)  $\text{H}_2\text{O}$  (E)  $\text{HF}$
27. Among the following compounds, whose molecular dipole is not zero?  
(A)  $\text{PF}_5$  (B)  $\text{PF}_3\text{Cl}_2$  (C)  $\text{PF}_2\text{Cl}_3$  (D)  $\text{P}_4$  (E)  $\text{BF}_3$
28. Among the following compounds, which has the largest bond angle?  
(A)  $\text{NF}_3$  (B)  $\text{PF}_3$  (C)  $\text{AsF}_3$  (D)  $\text{SbF}_3$  (E) all of the above
29. Among the following compounds, whose point group is  $C_{2v}$ ?  
(A)  $\text{BF}_3$  (B)  $\text{CF}_4$  (C)  $\text{NF}_3$  (D)  $\text{SF}_4$  (E) none of the above
30. Which of the following is chiral?  
(A)  $\text{C}_2\text{H}_2$  (B)  $\text{N}_2\text{H}_2$  (C)  $\text{H}_2\text{O}_2$  (D)  $\text{SeCl}_4$  (E) none of the above
31. In  $\text{Mo}(\text{CO})_6$ , the number of IR-active C-O stretching vibrations is  
(A) 1 (B) 2 (C) 3 (D) 4 (E) none of the above
32. In aqueous solutions, which of the following is the strongest acid?  
(A)  $\text{HNO}_3$  (B)  $\text{H}_2\text{SO}_4$  (C)  $\text{HClO}_4$  (D)  $\text{HCl}$  (E) all of the above
33. The spin multiplicity of  $\text{KO}_2$  is  
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4

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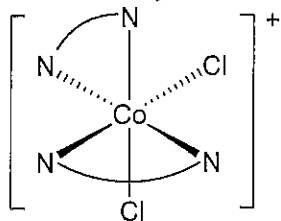
34. Which of the following is the softest Lewis base?

- (A)  $F^-$  (B)  $OH^-$  (C)  $H_2O$  (D)  $CO_3^{2-}$  (E)  $H^-$

35. The coordination geometry of  $Ni(CO)_4$  is

- (A) see-saw (B) square planar (C) tetrahedral (D) trigonal pyramidal (E) none of the above

36. The chirality label for the dichlorobis(ethylenediamine)cobalt(III) cation shown below is



- (A)  $\Delta$ -cis- (B)  $\Delta$ -trans- (C)  $\Lambda$ -cis- (D)  $\Lambda$ -trans- (E) none of the above

37. As a ligand, CO is a

- (A)  $\sigma$  donor and  $\pi$  donor (B)  $\sigma$  donor and  $\pi$  acceptor (C)  $\sigma$  acceptor and  $\pi$  donor (D)  $\sigma$  acceptor and  $\pi$  acceptor (E) none of the above

38. Which of the following does not show a Jahn-Teller effect?

- (A)  $[Cr(H_2O)_6]^{2+}$  (B)  $[Mn(H_2O)_6]^{2+}$  (C)  $[Fe(H_2O)_6]^{2+}$  (D)  $[Co(H_2O)_6]^{2+}$  (E) none of the above

39. The highest occupied molecular orbital(s) of  $[CuCl_2]^-$  is/are

- (A)  $3d_{x^2-y^2}$ ,  $3d_{z^2}$  (B)  $3d_{xy}$ ,  $3d_{xz}$ ,  $3d_{yz}$  (C)  $3d_{xz}$ ,  $3d_{yz}$  (D)  $3d_{z^2}$  (E) none of the above

40. Which of the following has a d-d transition?

- (A)  $TiO_2$  (B)  $VO_2$  (C)  $CrO_3$  (D)  $MnO_4^-$  (E) none of the above

41. The metal-metal bond order of  $Mo_2(\eta^5-C_5H_5)_2(CO)_4$  is

- (A) 0 (B) 1 (C) 2 (D) 3 (E) none of the above

42. Which of the following is the strongest trans influence ligand?

- (A)  $Cl^-$  (B)  $OH^-$  (C)  $NH_3$  (D)  $H^-$  (E) CO

43. In  $Fe(\eta^x-C_5H_5)(\eta^5-C_5H_5)(CO)_2$ , x =

- (A) 2 (B) 3 (C) 4 (D) 5 (E) none of the above



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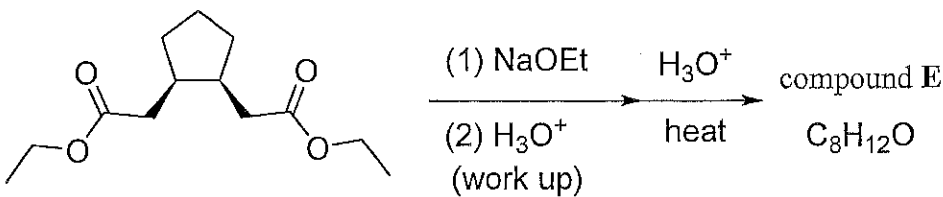
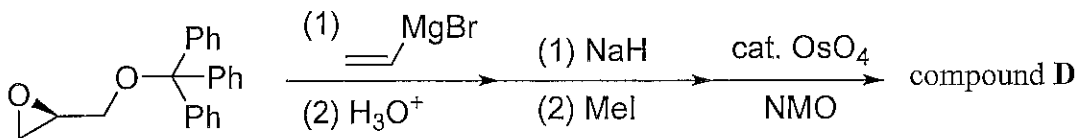
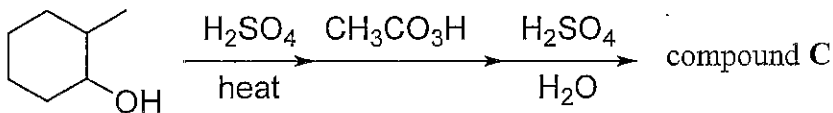
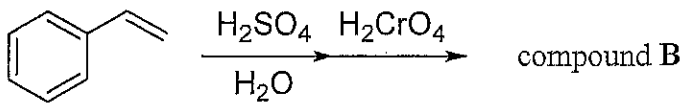
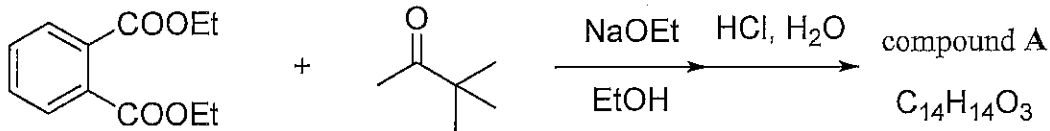
題號：422001

※本科目依簡章規定「不可以」使用計算機(混合題)

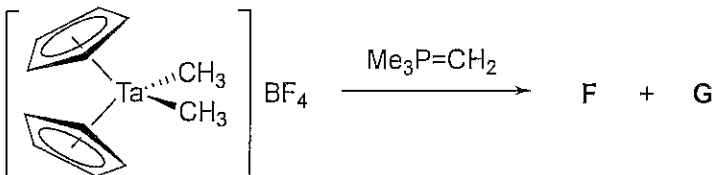
共 8 頁第 8 頁

二、非選擇題 (14%)

1. Draw the major product of each of the following reactions with correct stereochemistry where necessary: (2% × 5 = 10%)



2. Draw products F and G, where F is an organometallic complex. (2% × 2 = 4%)



# 國立中山大學 113 學年度

## 碩士班暨碩士在職專班招生考試試題

科目名稱：物理化學及分析化學【化學系碩士班】

### — 作答注意事項 —

考試時間：100 分鐘

- 考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- 答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以 2B 鉛筆劃記，不可使用修正液（帶）塗改，未使用 2B 鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- 試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。
- 試題採雙面列印，考生應注意試題頁數確實作答。
- 違規者依本校招生考試試場規則及違規處理辦法處理。

國立中山大學 113 學年度碩士班暨碩士在職專班招生考試試題

科目名稱：物理化學及分析化學【化學系碩士班】

題號：422002

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共 3 頁第 1 頁

選擇題：(單選題)

第 1-10 題，每題五分、共五十分

1. How many milliliters of 3.00 M  $\text{H}_2\text{SO}_4$  are required to react with 4.35 g of solid containing 23.2 wt%  $\text{Ba}(\text{NO}_3)_2$  (FM 261.34 g/mol) if the reaction is  $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4(\text{s})$ ?  
(A) 12.9 (B) 1.29 (C) 4.36 (D) 14.36 (E) 12.1
2. A 0.045 0 M solution of weak acid: HA is 0.60% dissociated. Calculate pKa for this acid.  
(A) 1.65 (B) 3.82 (C) 5.79 (D) 6.21 (E) 6.88
3. Find the pH of 0.050 M  $\text{HClO}_4$  plus 0.050 M  $\text{HBr}$ . ( $\mu = 0.050 \text{ M} \Rightarrow \gamma_{\text{H}^+} = 0.86$ ;  $\mu = 0.10 \text{ M} \Rightarrow \gamma_{\text{H}^+} = 0.83$ ).  
(A) 0.043 (B) 1.37 (C) 2.37 (D) 0.083 (E) 1.08
4. Calculate the pH of a solution prepared by dissolving 10.0 g of tris(hydroxymethyl)-aminomethane ("tris"; FM: 121.136 g/mol) plus 10.0 g of tris hydrochloride (FM: 157.597 g/mol) in 0.250 L of water.  
(A) 8.19 (B) 8.25 (C) 9.05 (D) 8.37 (E) 7.52
5. Calculate the isoelectric pH of 0.010 M 8-hydroxyquinoline.  $\text{pK}_{\text{a}1}$ : 4.94,  $\text{pK}_{\text{a}2}$ : 9.82  
(A) 5.36 (B) 6.36 (C) 7.36 (D) 8.36 (E) 9.36
6. Consider the diprotic acid  $\text{H}_2\text{A}$  with  $K_1 = 1.00 \times 10^{-4}$  and  $K_2 = 1.00 \times 10^{-8}$ . Find the pH of  $\text{HA}^-$  in 0.100 M  $\text{NaHA}$ .  
(A) 5.00 (B) 6.00 (C) 7.00 (D) 8.00 (E) 9.00
7. How many milliliters of 0.202 M  $\text{NaOH}$  should be added to 25.0 mL of 0.023 3 M salicylic acid (2-hydroxybenzoic acid) to adjust the pH to 3.50? [salicylic acid ( $\text{H}_2\text{A}$ ,  $\text{pK}_1 = 2.972$ ,  $\text{pK}_2 = 13.7$ )]  
(A) 1.023 (B) 2.223 (C) 3.323 (D) 4.023 (E) 5.223
8. A solution containing the complex formed between Bi(III) and thiourea has a molar absorptivity of  $9.32 \times 10^3 \text{ L mol}^{-1} \text{ cm}^{-1}$  at 470 nm. What is the absorbance of a  $3.79 \times 10^{-5} \text{ M}$  solution of the complex at 470 nm in a 1.00 cm cell?  
(A) 1.353 (B) 2.021 (C) 0.335 (D) 0.353 (E) 0.153
9. What kind of interferences may cause the complex spectra in atomic mass spectrometry?  
(A) Isobaric Interferences (B) Polyatomic Ion Interferences (C) Oxide and Hydroxide Species' Interference (D) none of the above (E) all of the above
10. A chromatography column with a length of 10.3 cm and an inner diameter of 4.61 mm is packed with a stationary phase that occupies 61.0% of the volume. If the volume flow rate is 1.13 mL/min, find the linear flow rate in cm/min.  
(A) 17.4 (B) 12.8 (C) 10.1 (D) 8.32 (E) 4.91

第 11-22 題，每題三分，共三十六分

11. If the reaction  $2\text{HBr} \rightarrow \text{H}_2 + \text{Br}_2$  belongs to second-order reaction, which of the following will yield a linear plot?  
(A).  $\ln[\text{HBr}]$  vs time.  
(B).  $[\text{HBr}]$  vs time.  
(C).  $1/[\text{HBr}]$  vs time.  
(D).  $1/\ln[\text{HBr}]$  vs time.  
(E).  $1/[\text{HBr}]^2$  vs time.
12. Which of the following phenomena or effect can be attributed to the quantum nature of light?  
(A). Blackbody radiation.  
(B). Photoelectric effect.  
(C). Laser.  
(D). Carrots look red.  
(E). All of these.

國立中山大學 113 學年度碩士班暨碩士在職專班招生考試試題

科目名稱：物理化學及分析化學【化學系碩士班】

題號：422002

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共 3 頁第 2 頁

13. A particle with mass  $m$  is moving freely in one dimension along  $x$  with zero potential energy. From the viewpoint of quantum mechanics, which following statement is wrong?
- (A). The time-independent Schrodinger equation is  $-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} \psi = E\psi$ .
- (B).  $\psi(x) = e^{ikx}$  can be the wavefunction for the particle with single linear momentum  $+\hbar k$ .
- (C).  $\psi(x) = \cos(kx)$  is one of solutions of its time-independent Schrodinger equation.
- (D). The total energy of the particle is quantized.
- (E). For  $\psi(x) = \cos(kx)$ , its expectation value of the operator  $\hat{p} = \frac{\hbar}{i} \frac{d}{dx}$  is equal to zero.
14. A particle is confined in a one-dimensional box with a finite length. The potential energies inside and outside the box are equal to zero and infinity, respectively. From the viewpoint of quantum mechanics, which of the following statement is wrong?
- (A). The degeneracy of each energy level is one.
- (B). The zero-point energy is equal to zero.
- (C). The wavefunction with a higher total energy has a larger number of nodes.
- (D). Outside the box, the value of the wavefunction is equal to zero.
- (E). The total energy is inversely proportional to the square of the length of the box.
15. The Schrodinger equation of a harmonic oscillator is  $\left(-\frac{\hbar^2}{2m} \frac{d^2}{dx^2} + \frac{1}{2} kx^2\right) \psi = E\psi$ , where  $x$  is displacement from the equilibrium position,  $m$  is mass and  $k$  is force constant. Which following statement is wrong?
- (A). The vibrational frequency is proportional to  $(k/m)^{1/2}$ .
- (B). The zero-point energy is not equal to zero.
- (C). The total energy is linearly proportional to vibrational frequency.
- (D). The expectation value of  $x$ ,  $\langle x \rangle$ , is equal to zero.
- (E). The degeneracy of each energy level is two.
16. For the ground state of helium atom, which following statement is wrong?
- (A). The total angular momentum of two electrons is zero.
- (B). A helium atom in the ground state is diamagnetic.
- (C). The term symbol is  $^1S_0$ .
- (D). Two electrons in helium are distinguishable.
- (E). The shielding effect of two 1s electrons to 2s orbital is smaller than that to 2p orbital.
17. For Born Oppenheimer approximation, which of the following statement is correct?
- (A). The motion of nuclei and the motion of the electrons are coupled.
- (B). The motion of electrons is much faster than that of nuclei due to their big differences in mass.
- (C). In the Hamiltonian operator, the electron-nucleus interactions are removed.
- (D). The electrons and nuclei are considered to have a similar speed.
- (E). The energy of electrons depends on positions and velocities of nuclei.
18. For reversible isothermal expansion of an ideal gas (system), which of the following statement is wrong?
- (A). The heat transfer is zero.
- (B). The change in the internal energy of the system is zero.
- (C). The work done by the system is not zero.
- (D). The entropy change of the system is positive.
- (E). The enthalpy change of the system is zero.

國立中山大學 113 學年度碩士班暨碩士在職專班招生考試試題

科目名稱：物理化學及分析化學【化學系碩士班】

題號：422002

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共 3 頁第 3 頁

19. For reversible adiabatic expansion of an ideal gas (system), which of the following statement is wrong?
- (A). The heat transfer is zero.  
 (B). The change in the internal energy of the system is zero.  
 (C). The work done by the system is not zero.  
 (D). The entropy change of the system is zero.  
 (E). The enthalpy change of the system is not zero.
20. For Gibbs energy,  $G$ , which of the following statement is wrong?
- (A). For a spontaneous process at constant temperature and pressure, the change in  $G$  is negative.  
 (B).  $G$  is defined by the equation:  $G = H - TS$ .  
 (C). Its fundamental thermodynamic relation is:  $dG = -SdT + PdV$ .  
 (D). The chemical potential of a pure substance is equal to its molar Gibbs energy.  
 (E).  $G$  is a state function.
21. If the reaction  $\text{CH}_3\text{NC} \rightarrow \text{CH}_3\text{CN}$  belongs to second-order reaction, which of the following will yield a linear plot?
- (A).  $\ln[\text{CH}_3\text{NC}]$  vs time  
 (B).  $[\text{CH}_3\text{NC}]$  vs time  
 (C).  $1/[\text{CH}_3\text{NC}]$  vs time  
 (D).  $1/\ln[\text{CH}_3\text{NC}]$  vs time  
 (E).  $1/[\text{CH}_3\text{NC}]^2$  vs time
22. For the Arrhenius equation,  $k = A \exp(-E_a/RT)$ , which of the following statement is wrong?
- (A). The effect of catalyst is to increase the magnitude of  $A$ .  
 (B). The pre-exponential factor  $A$  is associated with the collision frequency of reactants.  
 (C). The activation energy  $E_a$  can be positive or negative.  
 (D). The pre-exponential factor  $A$  includes the steric factor of reaction.  
 (E).  $\exp(-E_a/RT)$  represents the fraction of molecules with a kinetic energy larger than  $E_a$ .

計算題，每題七分，共十四分

1. One mole of  $\text{N}_2(\text{g})$  at 298 K expands adiabatically from a volume of 5.0 atm to 1.0 atm in following two conditions: (a) reversibly, and (b) against a constant external pressure of 1.0 atm. The molar heat capacity at constant volume is equal to  $5R/2$ . Determine the values of final temperature of  $\text{N}_2(\text{g})$ , for conditions (a) and (b).  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1} = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$

2. Consider the base-catalyzed reaction:  $\text{OCl}^-(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{OI}^-(\text{aq}) + \text{Cl}^-(\text{aq})$ . Use the following data of initial rate  $v_0$  to determine (a) the rate law and (b) the corresponding rate constant, including the unit, for the reaction.

$[\text{OCl}^-] / \text{M}$	$[\text{I}^-] / \text{M}$	$[\text{OH}^-] / \text{M}$	$v_0 / \text{M s}^{-1}$
$1.60 \times 10^{-3}$	$1.60 \times 10^{-3}$	0.52	$2.01 \times 10^{-4}$
$1.60 \times 10^{-3}$	$3.98 \times 10^{-3}$	0.52	$4.97 \times 10^{-4}$
$2.71 \times 10^{-3}$	$1.60 \times 10^{-3}$	0.84	$2.10 \times 10^{-4}$
$1.60 \times 10^{-3}$	$3.98 \times 10^{-3}$	1.01	$2.57 \times 10^{-4}$