國立中山大學112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(不得另攜帶紙張，亦不得使用應考證空白處作為計算紙使用)。
- 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，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）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112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】　　題號：422001

※本科目依簡章規定「不可以」使用計算機(混合題)　　

一、選擇題 (2% × 40 = 80%)

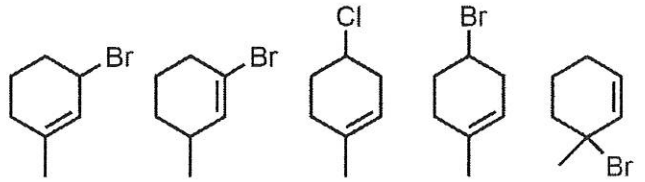
說明：全部單選，每題2分，答錯不倒扣。

1. Which of the species below is less basic than acetylide?

A) CH_3Li　B) CH_3ONa　C) CH_3MgBr　D) both A and C　E) all of the above

2. Rank the following molecules in order of increasing relative rate of S_N1 solvolysis with methanol and heat (slowest to fastest reacting).

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

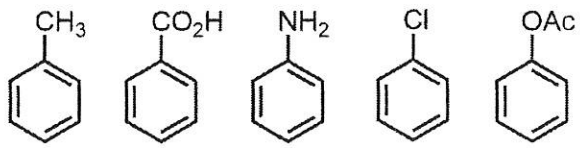


3. What compound is formed when 2,2-dimethyloxirane is treated with ethanol containing a trace of HCl?

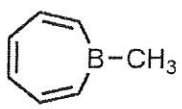
A) 2-ethoxy-2-methyl-1-propanol　B) 1-ethoxy-2-methyl-2-propanol
C) 2-ethoxy-2-methyl-2-propanol　D) 2-ethoxy-1-butanol
E) 1-ethoxy-2-butanol

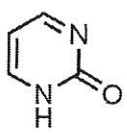
4. Rank the following compounds in order of increasing reactivity towards chlorination with $Cl_2/AlCl_3$ (slowest reacting to fastest).

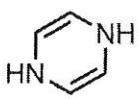
A) 3 < 4 < 2 < 1 < 5
B) 2 < 4 < 1 < 3 < 5
C) 4 < 2 < 1 < 3 < 5
D) 2 < 4 < 5 < 1 < 3
E) 2 < 4 < 1 < 5 < 3



5. Which of the following structures, if flat, would be classified as antiaromatic?

A) 

B) 

C) 

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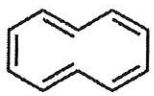
E) 

6. The Williamson ether synthesis proceeds via an _____ mechanism.

A) S_N1　B) S_N2　C) E1　D) E2　E) none of the above

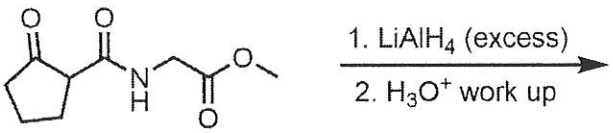
7. Which of the following is <u>least</u> likely to undergo a smooth crossed Claisen condensation with methyl pentanoate?

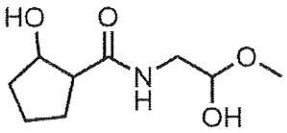
A) $(CH_3)_3CCO_2CH_3$　B) $PhCH_2CO_2CH_3$　C) $PhCO_2CH_3$　D) HCO_2CH_3　E) $(CH_3O)_2CO$

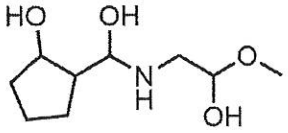
8. Which of the following describes an unsymmetrical addition reaction?

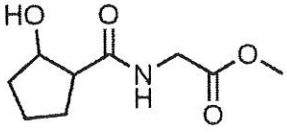
A) propyne with 1 mole H_2, Ni and heat　　B) propyne with 2 moles Cl_2 in CCl_4
C) propyne with 1 mole Br_2 in CCl_4　　D) propyne with Na/NH_3
E) propyne with 1 mole HBr

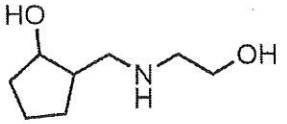
9. Predict the major product for the following reaction.

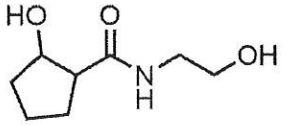


A) 

B) 

C) 

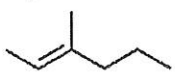
D) 

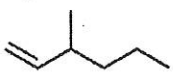
E) 

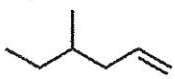
10. Which of the following reagents or sequences do <u>not</u> produce an alcohol or diol from an alkene starting material?

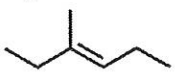
A) H^+, H_2O　　B) HCO_3H　　C) $BH_3 \cdot THF$ followed by H_2O_2, NaOH
D) $Hg(OAc)_2$, H_2O followed by $NaBH_4$　　E) OsO_4, H_2O_2

11. Which one of these alkene would be likely to experience a carbocation rearrangement when treated with aqueous acid?

A) 

B) 

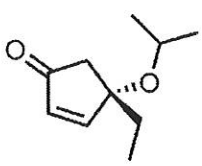
C) 

D) 

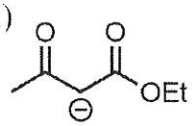
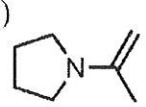
E) None of these would undergo a rearrangement

12. What is the complete systematic IUPAC name for the following compound?

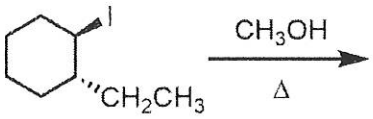
A) (*S*)-4-ethyl-4-isopropoxycyclopent-2-en-1-one
B) (*R*)-4-ethyl-4-isopropoxycyclopent-2-en-1-one
C) (*S*)-3-ethyl-3-isopropoxycyclopent-4-en-1-one
D) (*R*)-3-ethyl-3-isopropoxycyclopent-4-en-1-one
E) (*R*)- 4-isopropoxy-4-ethyl-cyclopent-2-en-1-one

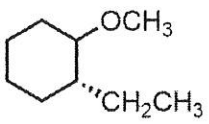
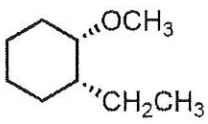
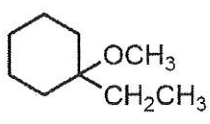
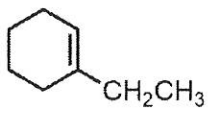
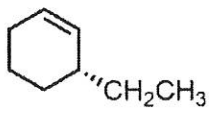


13. Which of the following is the best Michael acceptor?

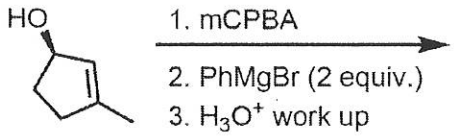
A) 
B) 
C) 
D) 
E) 

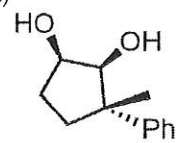
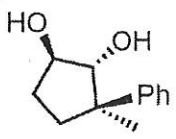
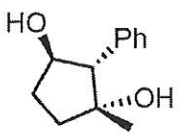
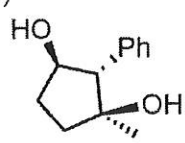
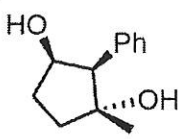
14. Provide the major organic product of the reaction below.



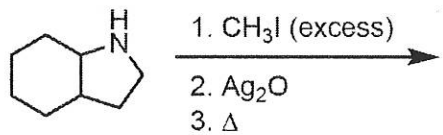
A) 
B) 
C) 
D) 
E) 

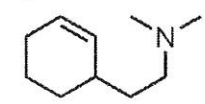
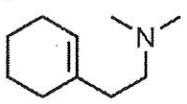
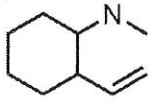
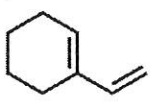
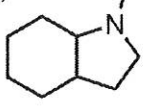
15. Provide the structure of the major organic product of the reaction below.



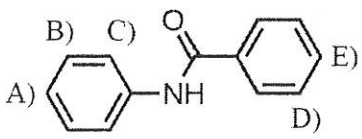
A) 
B) 
C) 
D) 
E) 

16. Provide the structure of the major organic product in the reaction below.

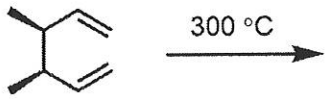


A) 
B) 
C) 
D) 
E) 

17. Which position of the molecule shown below is most likely to undergo a Friedel-Craft acylation?



18. What would be the resulting product when (*3R,4S*)-3,4-dimethylhexa-1,5-diene (shown below) is heated?



A) (±)-3,4-dimethyl-1,5-hexadiene
B) (*3S,4R*)-3,4-dimethylhexa-1,5-diene
C) (*2E,6E*)-octa-2,6-diene
D) (*2Z,6Z*)-octa-2,6-diene
E) (*2Z,6E*)-octa-2,6-diene

19. Which of the following has the highest first ionization energy?
A) He　B) Li　C) F　D) Ne　E) Na

20. Which of the following has the smallest covalent radius?
A) N　B) O　C) F　D) Cl　E) Br

21. How many angular nodes does a $3d_{xy}$ orbital have?
A) 0　B) 1　C) 2　D) 3　E) 4

22. How many π bonds does an O_2 molecule have?
A) 0　B) 1　C) 2　D) 3　E) 4

23. The valence electron configuration of ground state V^{2+} is
A) $4s^2 3d^3$　B) $4s^2 3d^1$　C) $4s^1 3d^2$　D) $3d^3$　E) $3d^5$

24. The bond order of S-O in SO_3 is
A) 1　B) 4/3　C) 3/2　D) 2　E) none of the above

25. The molecular geometry of SF_4 is best described as
A) tetrahedral　B) square planar　C) trigonal monopyramidal　D) square pyramidal　E) see-saw

26. Which of the following molecules is non-polar?
A) $PFCl_4$　B) PF_2Cl_3　C) PF_3Cl_2　D) PF_4Cl　E) none of the above

27. Anionic N_2^{2-} has a spin multiplicity of
A) 0　B) 1　C) 2　D) 3　E) 4

28. The point group of $CHCl_3$ is
A) T_d　B) C_s　C) C_3　D) C_{2v}　E) C_{3v}

29. In molecular orbital theory, how many group orbitals does CH_4 have?
A) 1　B) 2　C) 3　D) 4　E) 5

30. In H_2O, the wave function $\psi = c^1\psi(H^1) + c^2\psi(H^2) + c^3\psi(O)$ represents the group orbital that is highest in energy, where c^1, c^2, and c^3 are normalized coefficients. $c^1 + c^2 + c^3 =$
A) 0　B) 1　C) 2　D) 3　E) 4

31. Which of the following is the softest base?
A) H_2O　B) NH_3　C) PH_3　D) PF_3　E) too little information to tell

32. The magnetic moment (in μ_B) of $[Co(H_2O)_6]^{3+}$ =
A) 0　B) 1.4　C) 1.7　D) 2　E) none of the above

33. Which of the following shows a strong Jahn-Teller effect?
A) $[Sc(H_2O)_6]^{2+}$　B) $[Ti(H_2O)_6]^{2+}$　C) $[V(H_2O)_6]^{2+}$　D) $[Cr(H_2O)_6]^{2+}$　E) $[Mn(H_2O)_6]^{2+}$

34. The term symbol ${}^mL_J$ represents the ground term of atomic N having the lowest energy. J =
A) 0　B) 1/2　C) 1　D) 3/2　E) 2

35. Which of the following transitions are possible for $[MnO_4]^-$?
A) LMCT　B) MLCT　C) intra-ligand CT　D) d-d transition
E) at least two of the above transitions

36. Which of the following is true for tetrahedral $[FeCl_4]^-$?
A) it is diamagnetic
B) its magnetic moment = 1.7 μ_B
C) there are MLCT bands in its UV-vis spectrum
D) its spin multiplicity = 4
E) d-d transitions are spin forbidden

37. The valence electron count of $W(H_2)(CO)_2(PiPr_3)_2$ is
A) 14　B) 15　C) 16　D) 17　E) 18

38. Which set of orbitals in trigonal bipyramidal $[Cr(NH_3)_5]^{2+}$ is lowest in energy?
A) $3d_{x2-y2}$, $3d_{xy}$　B) $3d_{xz}$, $3d_{yz}$　C) $3d_{xy}$, $3d_{xz}$, $3d_{yz}$　D) $3d_{x2-y2}$, $3d_{z2}$　E) $3d_{x2-y2}$, $3d_{z2}$, $3d_{xy}$, $3d_{xz}$, $3d_{yz}$

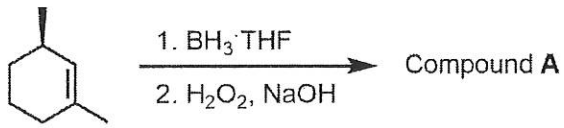
39. Among PPh_3, P(*o*-tolyl)$_3$, and P(*p*-tolyl)$_3$, whose Tolman cone angle is smallest?
A) only PPh_3
B) only P(*o*-tolyl)$_3$
C) only P(*p*-tolyl)$_3$
D) P(*o*-tolyl)$_3$ and P(*p*-tolyl)$_3$
E) PPh_3 and P(*p*-tolyl)$_3$

40. Among *fac*-$Mo(CO)_3(PF_3)_3$, *fac*-$Mo(CO)_3(PCl_3)_3$, and *fac*-$Mo(CO)_3(PMe_3)_3$, whose CO stretching frequency is highest?
A) only *fac*-$Mo(CO)_3(PF_3)_3$
B) only *fac*-$Mo(CO)_3(PCl_3)_3$
C) only *fac*-$Mo(CO)_3(PMe_3)_3$
D) *fac*-$Mo(CO)_3(PF_3)_3$ and *fac*-$Mo(CO)_3(PCl_3)_3$
E) *fac*-$Mo(CO)_3(PF_3)_3$, *fac*-$Mo(CO)_3(PCl_3)_3$, and *fac*-$Mo(CO)_3(PMe_3)_3$

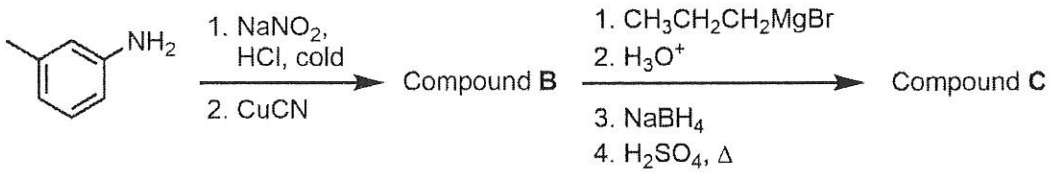
二、非選擇題 (20%)

1. Draw the structure of compound **A**, **B**, **C**, **D** and **E** with the correct stereochemistry where necessary. (2% × 5 = 10%)

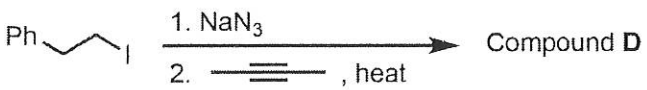
a)



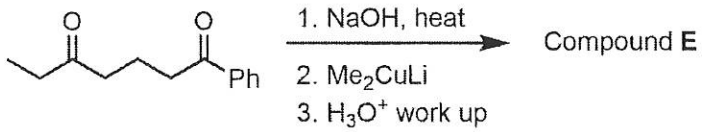
b)



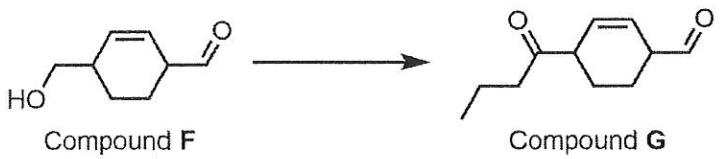
c)



d)

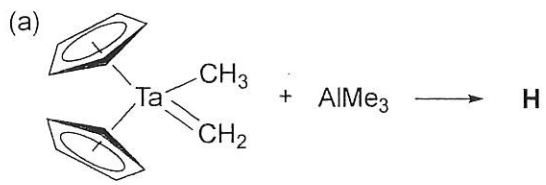


2. Design a synthesis of Compound **G** from Compound **F** (more than one step is required)? (4%)



3. Give structures of products **H**, **I**, and **J**. (2% × 3 = 6%)

(a)



(b)