Organic Chemistry (2nd semester)

Final examination (Friday, June , 2025, 8:00 ~ 10:00)

Name: 賴玟芳 ; Student ID number: 112023019 ; Score: _____/392

A. Select suitable answer of the following question (6 ps for each question, 150 pts total)

B

1. Rank the following compounds in order of decreasing basicity.

(a): aniline (b): pyridine (c): imidazole (d): pyrrole (e): triethylamine

(A) e > c > a > b > d (B) e > c > b > a > d (C) e > b > a > c > d

(D) c > e > a > b > d (E) c > b > a > d > e

C

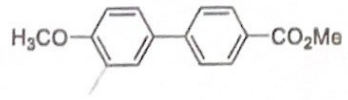
2. Rank the reactivity order toward electrophilic aromatic substitution for the following compounds.

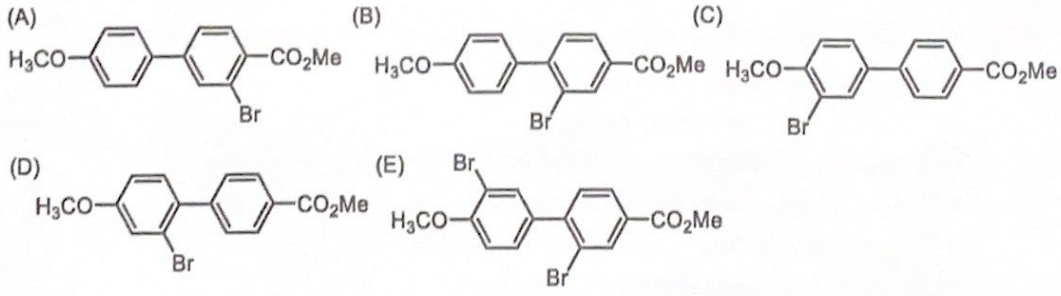
(A) b > a > c > d > e (B) a > b > d > e > c (C) b > c > a > d > e (D) c > a > b > e > d

(E) d > a > c > e > b

C

3. What product would be obtained from the reaction of the following compound with one equiv. of Br_2, using $FeBr_3$ as a catalyst?





A

4. When 2,4-dinitrochlorobenzene is treated with sodium hydroxide at 100 °C followed by protonation:

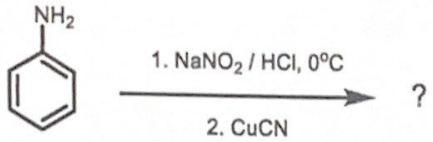
(A) 2,4-dinitrophenol is formed via an addition-elimination nucleophilic aromatic substitution mechanism.

(B) 2,4-dinitrophenol is formed via an elimination-addition nucleophilic aromatic substitution mechanism.

(C) 3,5-dinitrophenol is formed via an elimination-addition nucleophilic aromatic substitution mechanism.
(D) 3,5-dinitrophenol is formed via an electrophilic aromatic substitution mechanism.
(E) 2,4-dinitrophenol is formed via an electrophilic aromatic substitution mechanism.

B

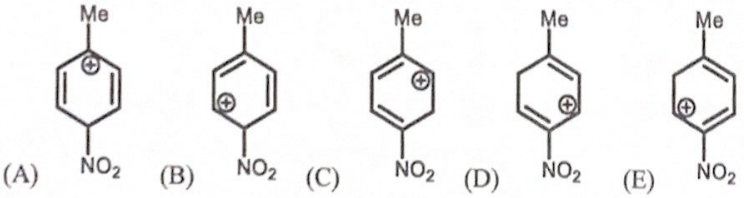
5. Identify the best product for the reaction.



(A) $PhCH_2NH_2$ (B) PhCN (C) $PhNH_2$ (D) PhCH=NH (E) Ph-Cu

A

6. Which of the following structures is the most important contributor to the resonance hybrid formed when toluene undergoes para nitration?



A

7. Which of the following is the electrophile that attacks the aromatic ring during sulfonation?

(A) HSO_3^+ (B) SO_2^+ (C) HSO_3^- (D) H_2SO_4 (E) HSO_4^-

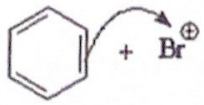
A

8. Which of the following is not a correct statement about the electrophilic substitution mechanism of benzene?

(A) Benzene functions as a nucleophile.
(B) Formation of a carbocation intermediate is the rate-determining step.
(C) The carbocation intermediate contains an sp^3 hybridized carbon in the ring.
(D) The addition product is a frequent minor product.
(E) Aromaticity is regained by loss of H^+.

C

9. Which of the following is the first step in the mechanism of bromination?

I. 

II. 

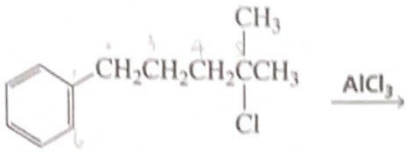
III. 

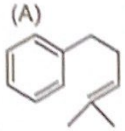
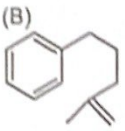
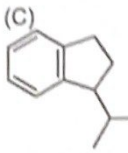
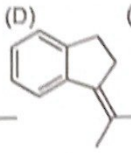
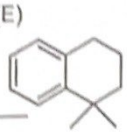
IV. 

V. 

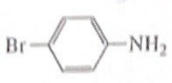
(A) I (B) II (C) III (D) IV (E) V

10. Predict the correct product structure.



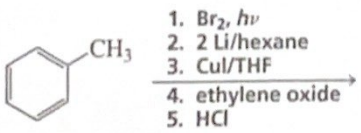
(A) 
(B) 
(C) 
(D) 
(E) 

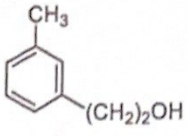
11. Rank the following substituted anilines from most basic to least basic:

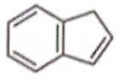
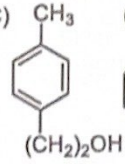
I 
II 
III 
IV 

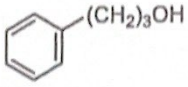
(A) II > I > IV > III (B) I > II > IV > III (C) III > II > I > IV
(D) I > IV > II > III (E) II > VI > I > III

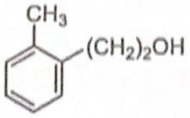
12. Predict the correct product structure.



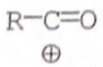
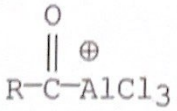
(A) 

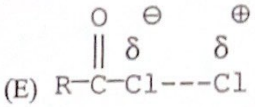
(B) 
(C) 

(D) 

(E) 

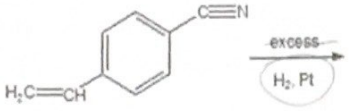
13. Which of the following is the electrophile that attacks the aromatic ring during Friedel-Crafts acylation?

(A) RC(O)Cl (B)  (C)  (D) $AlCl_3$

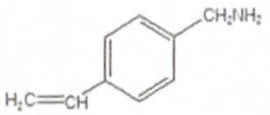
(E) 

E

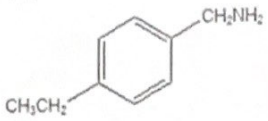
14. Identify the best product for the following reaction.



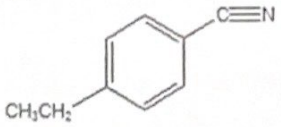
(A)



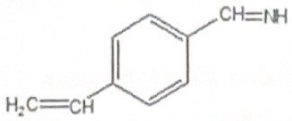
(B)



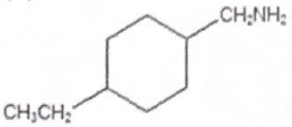
(C)



(D)

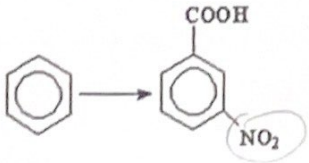


(E)



D

15. Which is the best method for carrying out the following reaction?



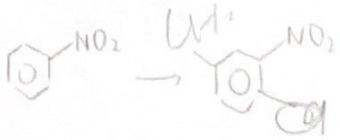
(A) $^{+}$COOH; HNO_3/H_2SO_4

(B) $CH_3Cl/AlCl_3$; HNO_3/H_2SO_4; $KMnO_4/H^+$, heat

(C) $CH_3Cl/AlCl_3$; $KMnO_4/H^+$, heat; HNO_3/H_2SO_4

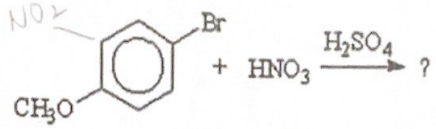
(D) HNO_3/H_2SO_4; $CH_3Cl/AlCl_3$; $KMnO_4/H^+$, heat

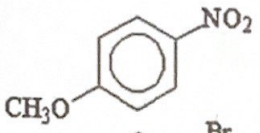
(E) HNO_3/H_2SO_4; $^{+}$COOH

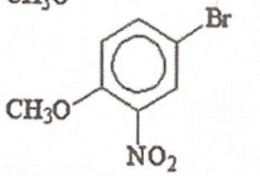


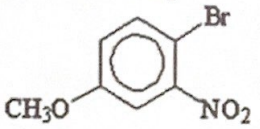
B

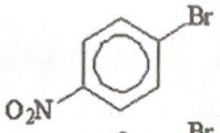
16. What is the major product of the following reaction?

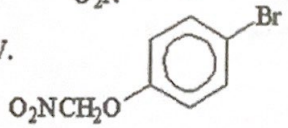


I. 

II. 

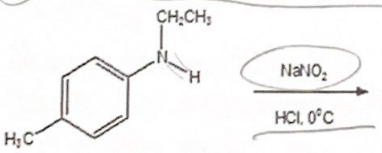
III. 

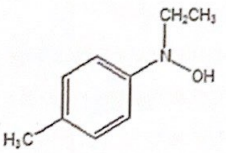
IV. 

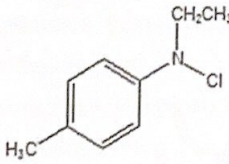
V. 

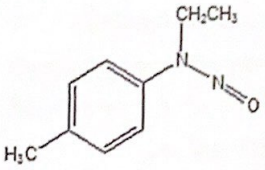
(A) I (B) II (C) III (D) IV (E) V

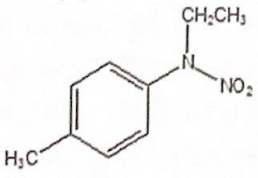
17. Identify the best product for the reaction.

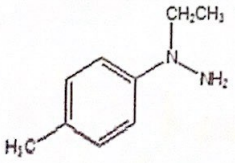


(A) 

(B) 

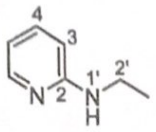
(C) 

(D) 

(E) 

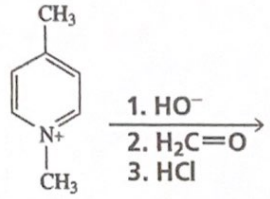
18. The following compounds undergoes electrophilic aromatic substitution

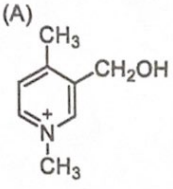
predominantly at which atom?

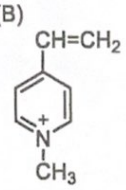


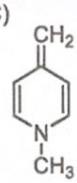
(A) C-2 (B) C-3 (C) C-4 (D) N-1' (E) C-2'

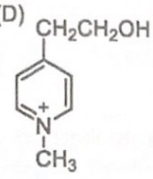
19. Predict the expected product structure.

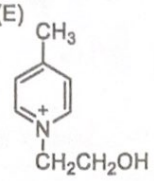


(A) 

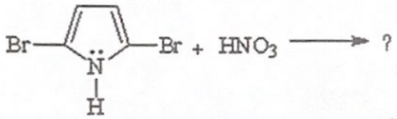
(B) 

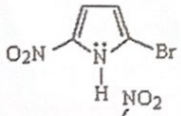
(C) 

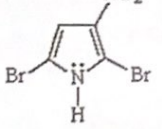
(D) 

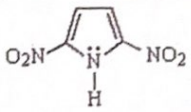
(E) 

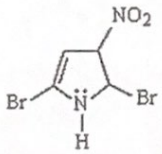
20. What is the major product of the following reaction?

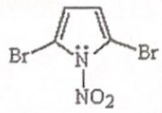


I. 

II. 

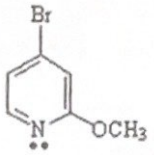
III. 

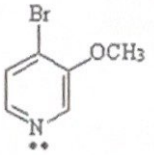
IV. 

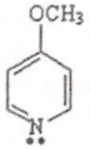
V. 

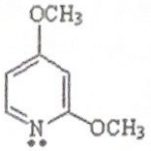
(A) I (B) II (C) III (D) IV (E) V

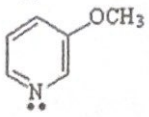
21. What is the major product of the following reaction?

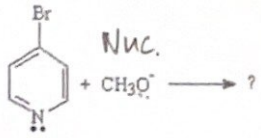
I. 

II. 

III. 

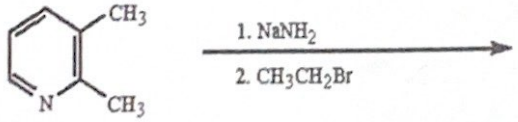
IV. 

V. 



(A) I (B) II (C) III (D) IV (E) V

22. What is the major organic product of the following reaction?

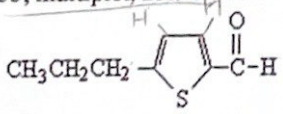


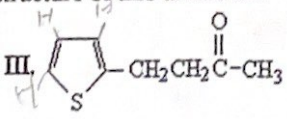
(A) 4-ethyl-2,3-dimethylpyridine (B) 5-ethyl-2,3-dimethylpyridine
(C) 6-ethyl-2,3-dimethylpyridine (D) 2-methyl-3-propylpyridine
(E) 3-methyl-2-propylpyridine

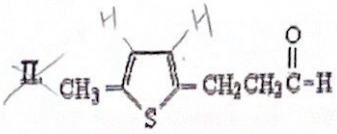
23. (i) Which heterocyclic ring is present in heme? (ii) How many pyrrole rings are represented in a heme heterocyclic ring system?

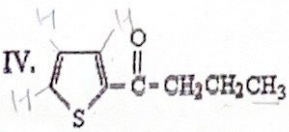
(A) (i) porphyrin (ii) 4 (B) (i) purine (ii) 4 (C) (i) imidazole (ii) 2
(D) (i) porphyrin (ii) 3 (E) (i) pyrimidine (ii) 4

24. An unknown compound has the formula $C_8H_{10}OS$, and is known to contain a thiophene ring. The proton NMR spectrum of this compound is:
δ0.98, triplet, 3H; δ1.74, multiplet, 2H; δ2.80, triplet, 2H; δ7.04, multiplet, 1H; δ7.55, multiplet, 2H. What is the structure of this unknown?

I. 

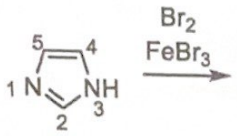
III. 

II. 

IV. 

(A) I (B) II (C) III (D) IV (E) none of the above

25. The following compounds undergoes electrophilic aromatic substitution predominantly at which atom?

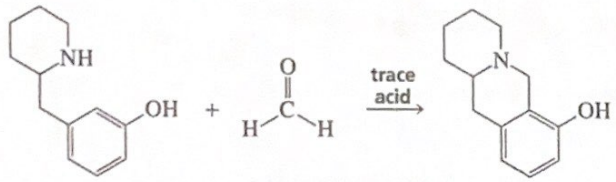


(A) N-1 (B) C-2 (C) N-3 (D) C-4 (E) C-5

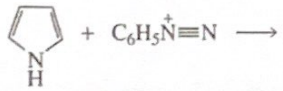
B. Propose a mechanism for each of the following transformation

(15 points for each question, total 60 pts)

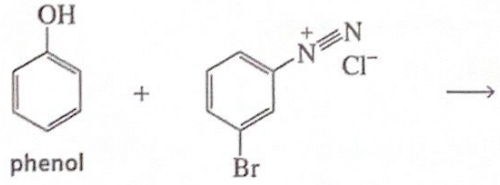
1.



2.



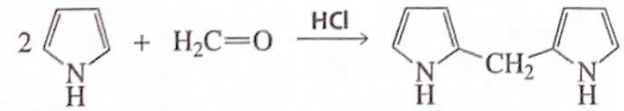
3. Predict the correct product and provide its mechanism.



phenol

m-bromobenzenediazonium chloride

4.

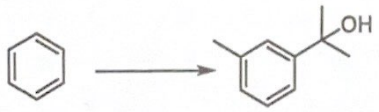


C. Provide suitable reagent for each of the following transformation

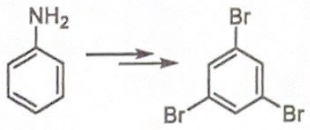
(15 points for each question, total 75 pts)

1.

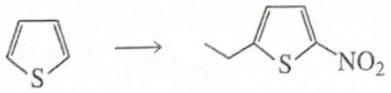
2.



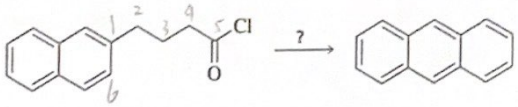
3.



4.



5.



D. Provide suitable answer(s) according to the following questions (total 92 pts)

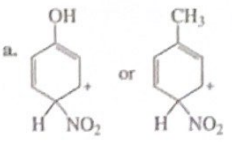
1. For each of the statements in Column I, choose a substituent from Column II that fits the description for the compound on the right: (12 pts)

Column I	Column II	
a. Z donates electrons by hyperconjugation and does not donate or withdraw electrons by resonance.	OH	A
b. Z withdraws electrons inductively and withdraws electrons by resonance.	Br	D
c. Z deactivates the ring and directs ortho–para.	NH_3	D
d. Z withdraws electrons inductively, donates electrons by resonance, and activates the ring.	CH_2CH_3	A
e. Z withdraws electrons inductively and does not donate or withdraw electrons by resonance.	NO_2	D

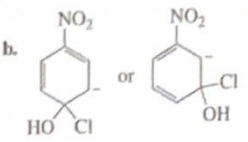
2. Which is a more stable intermediate in each pair? Explain your choice

(10 points for each question, total 20 pts)

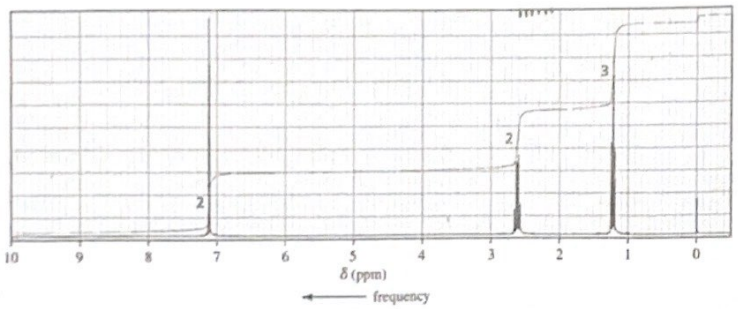
a.



b.

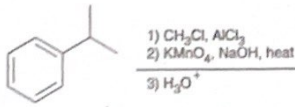


3. An unknown compound reacts with ethyl chloride and aluminum trichloride to form a compound that has the following 1H NMR spectrum. What is the structure of the compound? (10 points)

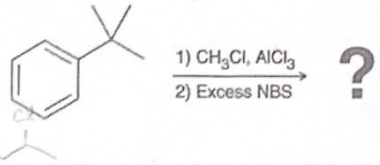


4. Predict the product of the following reactions:
(10 points for each question, total 20 pts)

(A)



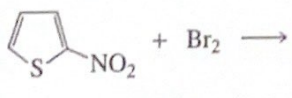
(B)



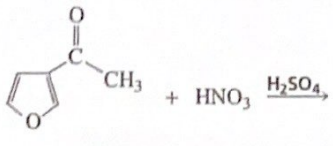
5. Benzene was treated with (R)-2-chlorobutane in the presence of aluminum trichloride, and the resulting product mixture was found to be optically inactive
(A) What products are expected, assuming that conditions are chosen to favor monoalkylation? (10 points)
(B) Explain why the product mixture is optically inactive. (5 points)

6. Predict the product of the following reactions. Explain your choice based on the resonance structures of the intermediates
(10 points for each question, total 20 pts)

(A)



(B)



7.

芳香式 10 pts