Questions 1-28: Please mark the appropriate box on the front of the Scantron form (3 pts each).

1. Which of the following compounds is a product of rearrangement formed by a 1,2-hydride shift in the reaction shown in the box?

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A)  
B)  
C)  
D)  
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2. Predict which one of the following groups will be meta-directing in the electrophilic aromatic substitution reaction?

A) –Cl    B) –N(CH₃)₂    C) –OH    D) –CHO

3. Arrange the following compounds according to their reactivity in electrophilic aromatic substitution reaction.

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1  2  3  4
A) (most reactive) 1 > 4 > 2 > 3 (least reactive)    B) (most reactive) 4 > 1 > 2 > 3 (least reactive)
C) (most reactive) 2 > 3 > 4 > 1 (least reactive)    D) (most reactive) 3 > 4 > 2 > 1 (least reactive)
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4. For the compound shown in a box, which labeled position is the most reactive in electrophilic aromatic substitution reactions?

![Compound Image]

5. Which of the following is a key intermediate for the transformation in the box?

A) \( \text{H}_2\text{N}-\text{SO}_2\text{H} \)  
B) \( \text{H}_2\text{N}-\text{H} \)  
C) \( \text{H}_2\text{N}=\text{NO}_2 \)  
D) \( \text{H}_2\text{N}-\text{NO}_2 \)

6. Predict which one of the following groups will be ortho/para-directing in the electrophilic aromatic substitution reaction?

A) \( -\text{CF}_3 \)  
B) \( -\text{S}-\text{CH}_3 \)  
C) \( -\text{F}^- \)  
D) \( -\text{S}^+\text{CH}_3 \)

7. Which one of the following four schemes (A-D) gives the best representation of the initial step of the mechanism of the reaction in the box?

![Reaction Scheme Image]
8. What is the structure of the intermediate for the reaction in the box?

9. What is the structure of the intermediate for the reaction in the box?

10. What is the name of the product formed in the following reaction?

11. What is a major product in the following reaction?

12. What is the name of the product formed in the following reaction?
13. What is a major product of the following sequence of reactions?

\[ \text{CH}_3 \quad \text{Cl}_2, \text{FeCl}_3 \xrightarrow{\text{heat}} \quad \text{K}_2\text{Cr}_2\text{O}_7, \text{H}_2\text{SO}_4 \xrightarrow{\text{heat}} \text{?} \]

14. Which one of the following compounds is the most reactive towards nucleophilic aromatic substitution reaction with NaOH?

A) \( \text{NH}_2 \)
B) \( \text{I} \)
C) \( \text{O}_2\text{N} \)
D) \( \text{O}_2\text{N} \)

15. What is a major product in the following reaction?

\[ \text{O}_2\text{N} \quad \text{NO}_2 \quad \text{(CH}_3\text{)}_2\text{NH (excess)} \xrightarrow{?} \text{?} \]

16. What is a major product of the following sequence of reactions?

\[ \text{F} \quad \text{NH}_3 \text{ (excess)} \xrightarrow{\text{SO}_3, \text{H}_2\text{SO}_4} \text{?} \]

17. Which is the correct order of basicity of the following compounds:
(1) ethylamine; (2) \( \text{NH}_3 \); (3) 2,4-dimethylaniline; (4) 2,4-dinitroaniline; (5) \( p \)-nitroaniline

A) 1 (strongest) > 2 > 3 > 5 > 4 (weakest)  B) 2 (strongest) > 4 > 1 > 3 > 4 (weakest)
C) 3 (strongest) > 1 > 2 > 5 > 4 (weakest)  D) 4 (strongest) > 5 > 3 > 2 > 1 (weakest)
18. Which of the following structures represent reasonable resonance contributors of o-nitroaniline?

A) 1 and 2    (B) 3 and 4    (C) 3 and 5    (D) 4 and 6

19. Which one of the following amines is the strongest base?

A) o-nitroaniline    B) 4-methylaniline    (C) butanamine    D) aniline

20. Which is the most acidic hydrogen in the compound shown in a box?

21. Which statement regarding the basicity of the aromatic heterocycle shown in the box is correct?

A) Both nitrogen atoms are strongly basic    B) Nitrogen N2 is not basic, N1 is basic
   (C) Nitrogen N1 is not basic, N2 is basic    D) Neither nitrogen atoms are basic

22. What is the name of the major product of the reaction shown in the box?

A) p-aminophenol    B) trans-4-aminocyclohexanol
   (C) cis-4-aminocyclohexanol    D) cis-4-bromocyclohexanamine
23. What is the major **product** of the reaction shown in the box?

![Chemical Reaction Diagram]

24. What is the name of the major **product** of the reaction shown in the box?

![Chemical Reaction Diagram]

25. What is the major **product** of the reaction shown in the box?

![Chemical Reaction Diagram]

26. What is the major **product** of the reaction shown in the box?

![Chemical Reaction Diagram]

27. Which reaction sequence will give **PhCH₂N(CH₃)₂** in high yield?

A) ![Chemical Reaction Diagram]

B) ![Chemical Reaction Diagram]

C) ![Chemical Reaction Diagram]

D) ![Chemical Reaction Diagram]
28. Which reaction sequence will accomplish transformation shown in the box?

Questions 29, 30: Please put your answers into the appropriate space on the back of the Scantron form (16 pts). PLEASE SHOW FORMULAS, DO NOT WRITE NAMES.

29. Provide substituent at the end of the bond in the box (4 pts):

30. Provide the reagents or reactant that give the indicated product in high yield (4 pts each):