Mock Exam 3
CH 237-2F

Multiple Choice:

1. Rank the following three compounds in order of decreasing (most to least) reactivity toward electrophilic bromination.

   ![Compounds]

   a) I > II > III
   b) III > II > I
   c) II > I > III
   d) I > III > II
   e) II > III > I

2. The mechanism for the reaction shown involves:

   ![Reaction]

   a) SN1 substitution of Cl by –OH
   b) SN2 substitution of Cl by –OH
   c) An elimination-addition sequence involving a substituted benzyne as an intermediate.
   d) Nucleophile attack by –OH at the chlorine-bearing carbon, resulting in the formation of an anion that subsequently loses Cl-. 
   e) Electrophilic attack by –OH at the chlorine-bearing carbon, resulting in the formation of a cation that subsequently loses Cl-.
3. How many benzylic hydrogens are present in the molecule?

![Molecule Diagram]

a) 3  
b) 4  
c) 5  
d) 6  
e) 8

4. Which of the following cannot be oxidized to benzoic acid?

![Chemical Structures]

a)  
b)  
c)  
d)  
e)  

5. Where would the compound shown below most likely undergo nitration by HNO₃/H₂SO₄?

![Nitrated Compound]

a) ortho/para positions on ring 1  
b) meta position on ring 1  
c) ortho/para position on ring 2  
d) meta position on ring 2  
e) Compound cannot be nitrated.
6. Nucleophilic aromatic substitution by HO- will occur most rapidly with which of the following compounds?

\[
\begin{array}{cccc}
\text{a) } & \text{b) } & \text{c) } & \text{d) } & \text{e) }
\end{array}
\]

7. Which of the following are requirements for aromaticity?

I. cyclic and conjugated pi electrons
II. 4n pi electrons in the ring
III. all the ring atoms must be carbons
IV. \((4n + 2)\) pi electrons in the ring

a) I and II
b) I and IV
c) I, II, and III
d) I, III, and IV
e) Only I

8. Which of the following reactions could be used to synthesize t-butylbenzene?

\[
\begin{array}{ccc}
\text{A} & \text{H}_3\text{PO}_4 & \text{B} \\
\end{array}
\]
9. Which of the following are aromatic? Assume all can be flat.
10. Which of the following is an acylium ion?
11. Which of the following is/are intermediate(s) in the bromination of toluene?

Please see link underneath mock exam for these three questions (9-11)

12. Consider the reaction shown below:

Which of the following are formed in this reaction (consider major products only)?

a) I, III
b) II, V
c) V
d) I, III, IV, VI
e) No reaction takes place.
13. Which of the following has the most basic nitrogen?

I  
II  
III  
IV

a) I  
b) II  
c) III  
d) IV  
e) More than one is correct.

14. Which combination of carbonyl compound and amine can be used to prepare the following product by reductive maintain?

I +  
II +  
III +
15. In which orbital are the lone pair electrons on the nitrogen atom of pyrrole located?

- a) sp3
- b) s
- c) sp2
- d) p
- e) sp
16. Consider the following reaction: (20 pts)

\[
\text{Br} \quad \text{Cl}_2, \text{FeCl}_2 \quad \text{Br} \quad \text{Cl}
\]

a) Draw a detailed mechanism for the chlorination of bromobenzene in the ortho position. Your mechanism should show every step of the reaction including formation of the electrophile. Use arrows to indicate flow of electrons. Draw all relevant resonance structures for the cation intermediate.

b) Draw all the relevant resonance structures for the cation intermediate if substitution occurred at the meta position.

c) Use your answers to a and b to briefly explain why only the ortho and para products are formed but not the meta.
17. Give the major organic product(s) of each of the following reactions. If no reaction occurs, write N.R. (30 pts)
18. Give the structure for compounds A-E. (10 pts)

19. Complete the following synthesis shown below using any organic or inorganic compounds. All reagents, solvents, and intermediate products must be shown in order to receive full credit. Assume isomers can be separated. (10 pts)