Please answer 20 of the 25 questions below. Clearly circle the numbers of the 5 problems you do NOT want me to grade. Do NOT circle more than 5. Do NOT circle less than 5. I will only grade 20 problems. Each problem is worth 5 points.

SHORT ANSWER

1. Explain the difference between a nucleophile and an electrophile.

2. Explain what an organic reaction mechanism is.

3. Explain the difference between spectrometry and spectroscopy.


5. Explain what a carbonyl is in terms of structure and reactivity.
6. What is the IUPAC name of the compound shown above?

7. How many signals would be observed in the proton NMR spectrum of the compound shown above?

8. What would be the m/z value for the molecular ion in the mass spectrum of the compound shown above?

9. Is the compound shown above aromatic? Why or why not?

10. What product or products would be generated from reaction of the compound shown above with nitric acid in the presence of sulfuric acid?

11. Show a mechanism for the reaction of the compound shown above with bromine in the presence of heat or light.
12. Outline a reasonable synthesis of the compound shown above from benzene.

13. Show the major product that would be generated from each of the reactions shown below:

14. Show the products that would be generated in the two-step sequence of reactions below:
15. Show a mechanism for the acid-catalyzed esterification of benzoic acid with excess methanol.

MULTIPLE CHOICE

16. The major monobrominated product that results when methylcyclohexane is subjected to free radical bromination is:
   (a) a primary bromide  (c) a tertiary bromide
   (b) a secondary bromide (d) a quaternary bromide

17. Which of the following factors has NO effect on the rate of an S_N1 reaction?
   (a) The nature of the alkyl halide.
   (b) The nature of the leaving group.
   (c) The concentration of the alkyl halide.
   (d) The concentration of the nucleophile.

18. What product results from the S_N2 reaction between (R)-2-chloropentane and hydroxide?
   (a) (R)-2-pentanol  (c) racemic pentanol
   (b) (S)-2-pentanol  (d) 3-pentanol

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

   ![Reaction Diagram]

   (a)  (b)  (c)  (d)
20. What are the major products from the following reaction?

\[ \text{H-Br} \quad \Delta \]

\[ \text{(a) } \begin{array}{c} \text{O} \\ \text{H} \end{array} + \begin{array}{c} \text{O} \\ \text{H} \end{array} \quad \text{(b) } \begin{array}{c} \text{O} \\ \text{H} \end{array} + \begin{array}{c} \text{O} \\ \text{H} \end{array} \quad \text{(c) } \begin{array}{c} \text{O} \\ \text{H} \end{array} + \begin{array}{c} \text{O} \\ \text{H} \end{array} \quad \text{(d) } \begin{array}{c} \text{O} \\ \text{H} \end{array} + \begin{array}{c} \text{O} \\ \text{H} \end{array} \]

21. Which of the compounds shown has a Hückel number of \( \pi \) electrons?

\[ \text{(a) } \begin{array}{c} \text{O} \\ \text{H} \end{array} \quad \text{(b) } \begin{array}{c} \text{O} \\ \text{H} \end{array} \quad \text{(c) } \begin{array}{c} \text{O} \\ \text{H} \end{array} \quad \text{(d) } \begin{array}{c} \text{O} \\ \text{H} \end{array} \]

22. Which of the following compounds reacts most slowly in a nitration reaction?

\[ \text{(a) } \begin{array}{c} \text{CH}_3 \\ \text{OCH}_3 \end{array} \quad \text{(b) } \begin{array}{c} \text{CH}_3 \\ \text{OCH}_3 \end{array} \quad \text{(c) } \begin{array}{c} \text{CH}_3 \\ \text{OCH}_3 \end{array} \quad \text{(d) } \begin{array}{c} \text{CH}_3 \\ \text{OCH}_3 \end{array} \]

23. Which of the following compounds is least reactive toward nucleophilic acyl substitution?

\[ \text{(a) } \begin{array}{c} \text{CH} \\ \text{OCH}_3 \end{array} \quad \text{(b) } \begin{array}{c} \text{CH} \\ \text{OCH}_3 \end{array} \quad \text{(c) } \begin{array}{c} \text{CH} \\ \text{OCH}_3 \end{array} \quad \text{(d) } \begin{array}{c} \text{CH} \\ \text{OCH}_3 \end{array} \]

24. Which of the following compounds is methyl benzoate?

\[ \text{(a) } \begin{array}{c} \text{O} \\ \text{CH}_3 \end{array} \quad \text{(b) } \begin{array}{c} \text{O} \\ \text{CH}_3 \end{array} \quad \text{(c) } \begin{array}{c} \text{O} \\ \text{CH}_3 \end{array} \quad \text{(d) } \begin{array}{c} \text{O} \\ \text{CH}_3 \end{array} \]
25. Which of the following conditions will drive the equilibrium of a Fischer esterification towards ester formation?
(a) addition of water
(b) removal of water as it is formed
(c) addition of excess alcohol
(d) both (b) and (c)