

CHM 202- Organic Chemistry II

Exam 2

Oct. 23, 2007

Name : _____

C#: _____

To receive proper credit for this exam, please bubble in your name and C# on your Scantron.

33 questions. 100 pts total. All questions worth an equal amount.

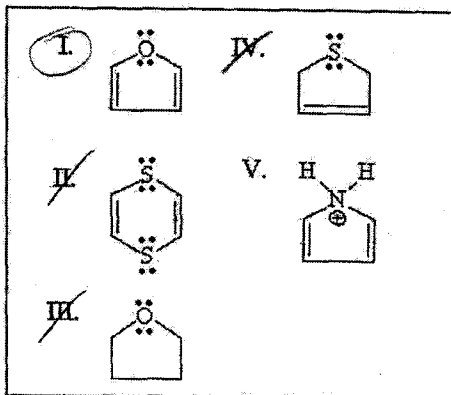
The last page contains a scratch sheet. You can rip it out after we tell you to begin.

Please ask for extra scratch paper if you need it.

Test taking tip: You can work questions in any order. Answer the ones that seem shorter and/or more straightforward first. Don't dwell on any one question if you don't have an idea how to answer it. Simply flag it and return to it later, time permitting.

1. Which of the following is aromatic?

- a. I
- b. II
- c. III
- d. IV
- e. V

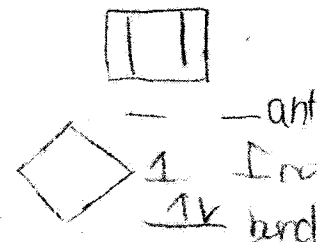


2. Indicate whether the following is (a) aromatic, (b) anti-aromatic, or (c) non-aromatic.



3. Which of the following statements about the π molecular orbital description of cyclobutadiene is not correct?

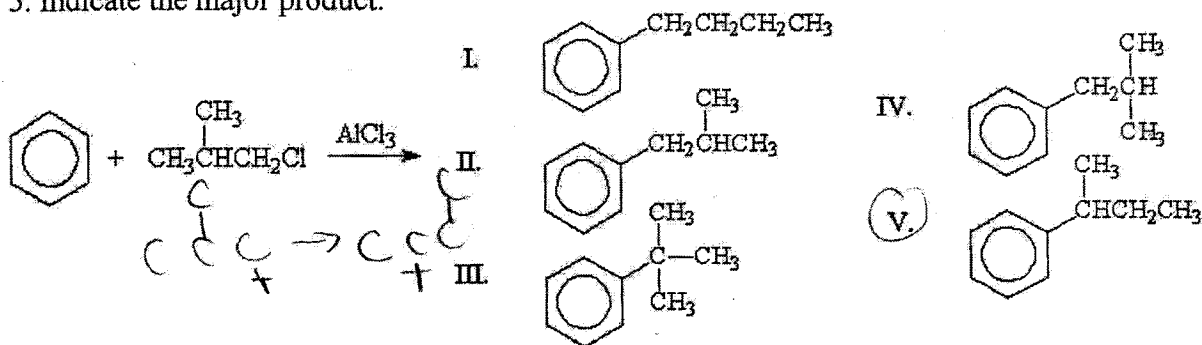
- a. Cyclobutadiene has a single bonding π molecular orbital
- b. Cyclobutadiene has two electrons in nonbonding π molecular orbitals
- c. Cyclobutadiene has one electron in an antibonding π molecular orbital which makes it antiaromatic
- d. Cyclobutadiene has two degenerate nonbonding π molecular orbitals
- e. none of the above



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

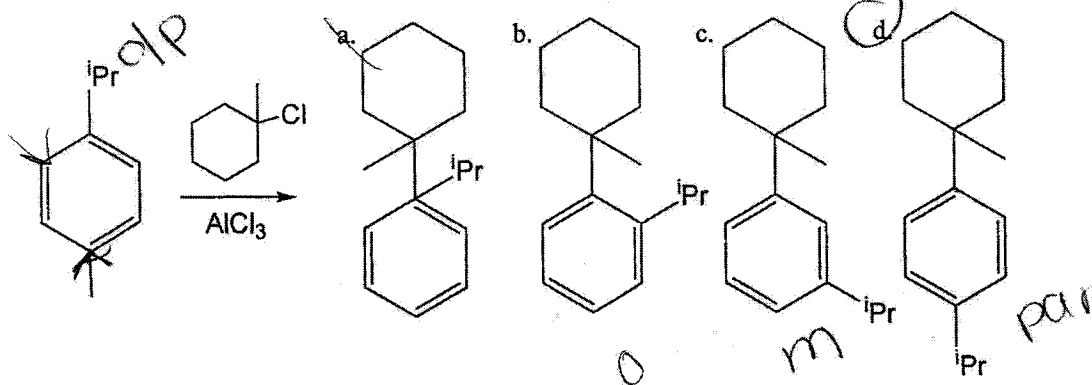
- a. Benzene functions as a nucleophile
- b. The carbocation intermediate contains an sp^3 hybridized carbon in the ring
- c. Formation of a carbocation intermediate is the rate-determining step
- d. The addition product is a frequent minor product
- e. Aromaticity is regained by loss of H^+

5. Indicate the major product.



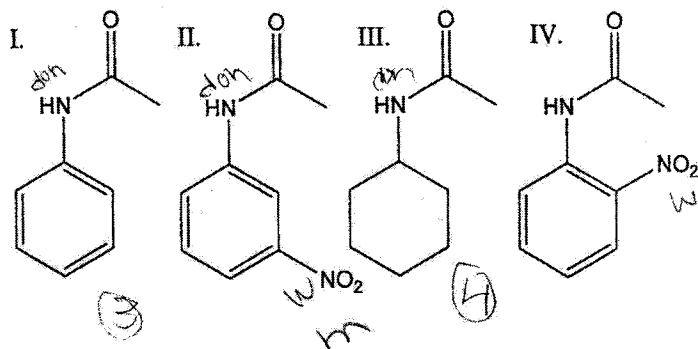
- a. I b. II c. III d. IV **e. V**

6. Indicate the major product. ⁱPr = isopropyl



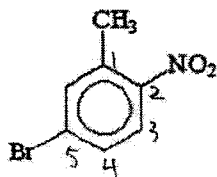
7. List the following amides in decreasing order of reactivity towards acid-catalyzed hydrolysis. (e.g. from most reactive to least)

- ~~a. II > IV > III > I~~
~~b. III > I > IV > II~~
~~c. I > III > II > IV~~
d. IV > II > I > III
 e. II > IV > I > III



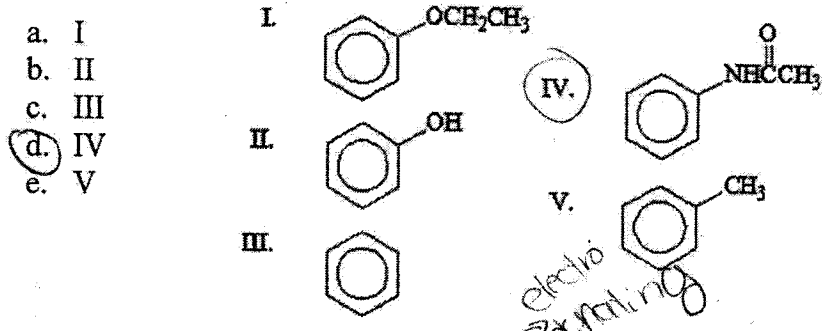
8. Name the following.

- a. 5-bromo-2-nitrotoluene**
 b. 3-bromo-6-nitrotoluene
 c. *o*-nitro-*m*-bromotoluene
 d. 2-nitro-5-bromotoluene
 e. *m*-bromo-*o*-nitrotoluene

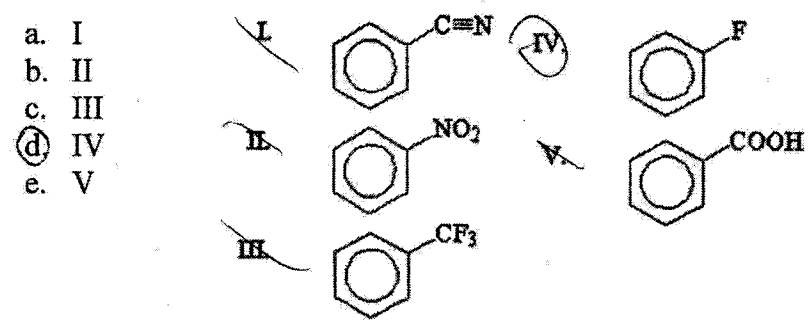


slowly = unreactive → chp 14

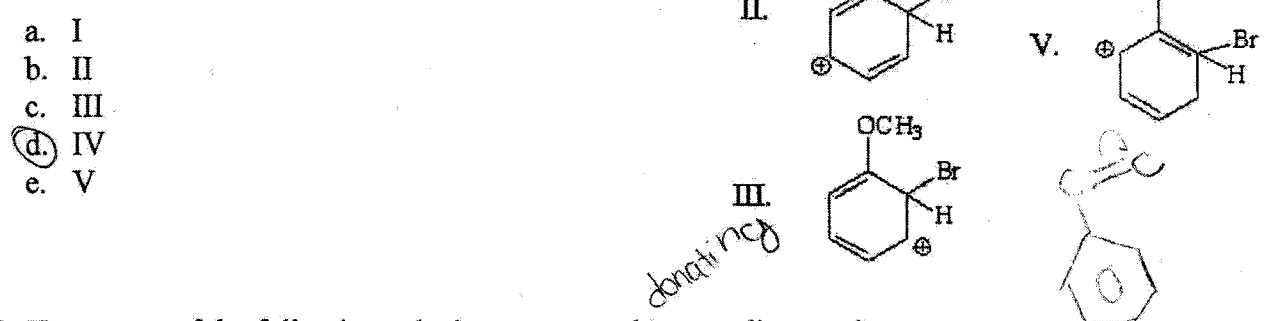
9. Which of the following reacts most slowly during nitration?



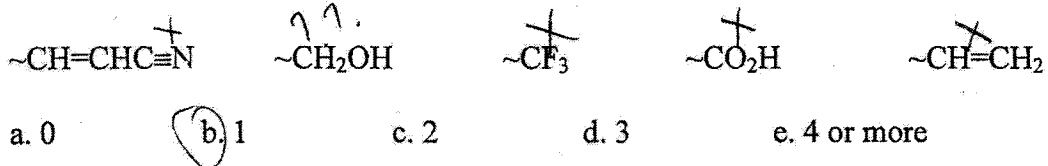
10. Which of the following reacts most rapidly during nitration?



11. Which of the following is the most important contributor to the resonance hybrid formed when anisole (methoxybenzene) undergoes *o*-bromination?



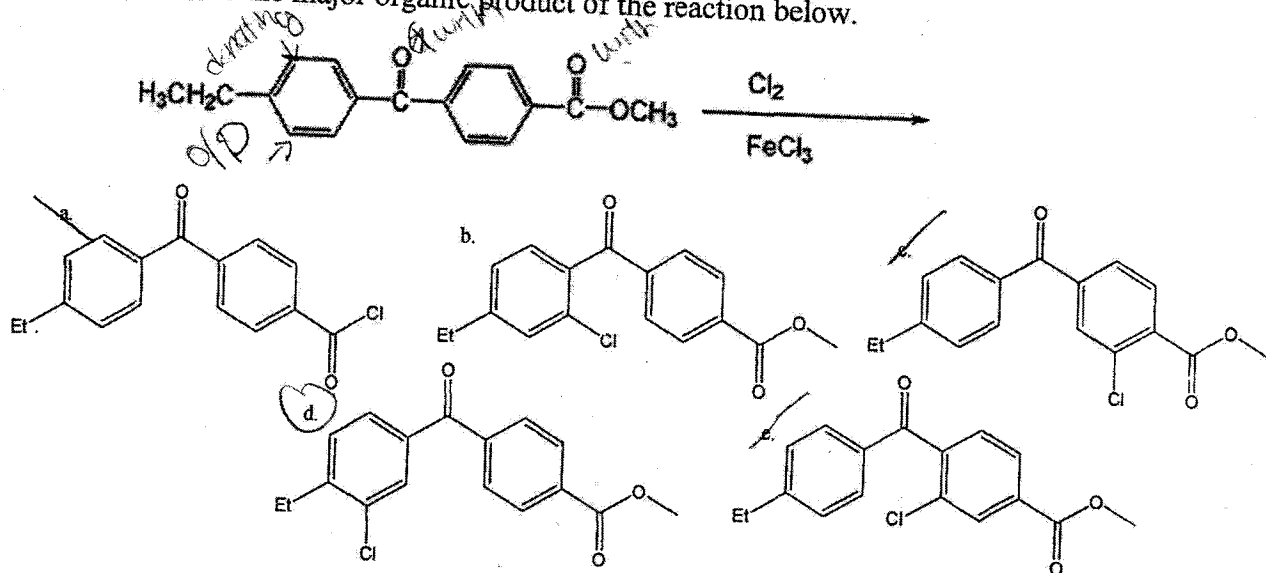
12. How many of the following substituents are *ortho-para* directors?



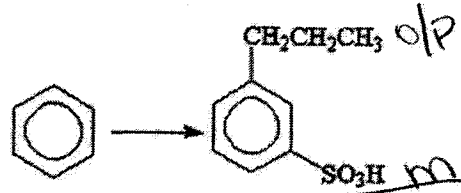
13. Which of the following monoalkylbenzenes undergo nitration in $\text{HNO}_3/\text{H}_2\text{SO}_4$ to yield a product mixture with the highest *ortho* : *para* ratio?

- a. toluene b. ethylbenzene c. propylbenzene d. *tert*-butylbenzene
e. isopropylbenzene

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



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

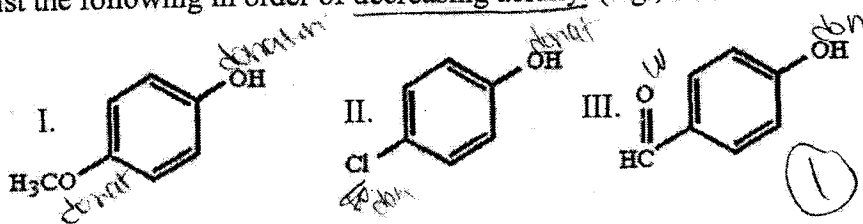


- I. $\text{SO}_3/\text{H}_2\text{SO}_4$; $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}/\text{AlCl}_3$
- II. $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}/\text{AlCl}_3$; $\text{SO}_3/\text{H}_2\text{SO}_4$
- III. $\text{CH}_3\text{CH}_2\text{COCl}/\text{AlCl}_3$; $\text{SO}_3/\text{H}_2\text{SO}_4$
- IV. $\text{CH}_3\text{CH}_2\text{COCl}/\text{AlCl}_3$; $\text{Zn}(\text{Hg})/\text{HCl}/\text{heat}$; $\text{SO}_3/\text{H}_2\text{SO}_4$
- V. $\text{CH}_3\text{CH}_2\text{COCl}/\text{AlCl}_3$; $\text{SO}_3/\text{H}_2\text{SO}_4$; $\text{Zn}(\text{Hg})/\text{HCl}/\text{heat}$

a. I b. II c. III d. IV e. V

withdraw
more deactivating, greater acidity

16. List the following in order of decreasing acidity. (e.g., from most acidic to least)



a. I > III > II
e. II > I > III

b. II > III > I

c. III > II > I

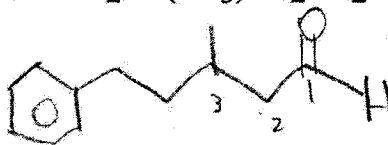
d. I > II > III

17. What is the best method for the preparation of *m*-dibromobenzene from benzene?

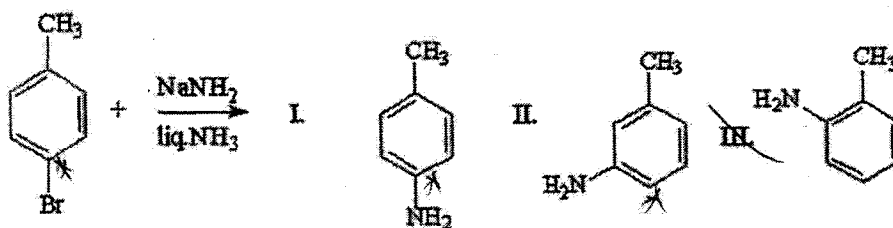
- a. nitrate; Sn/HCl; NaNO₂/HCl, 0°C; brominate twice
- b. nitrate; Sn/HCl; NaNO₂/HCl, 0°C; H₃PO₂; brominate twice ~~X~~
- c. nitrate; Sn/HCl; NaNO₂/HCl, 0°C; brominate twice; H₃PO₂
- d. brominate twice ✓
- e. nitrate; brominate; Sn/HCl; NaNO₂/HCl, 0°C; CuBr ~~HBr~~ ✓

18. Provide the proper IUPAC name for PhCH₂CH(CH₃)CH₂CH₂CHO. Ph = C₆H₅

- a. 3-methyl-4-benzylbutanone
- b. 3-methyl-4-benzylbutanal
- c. 3-methyl-5-phenylpentanone
- d. 2-methylpentanallylbenzene
- e. 3-methyl-5-phenylpentanal



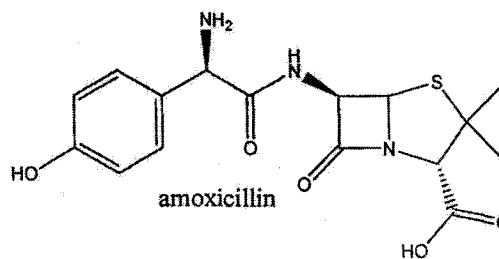
19.



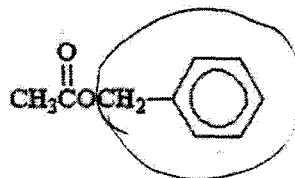
- a. I
- b. II
- c. III
- d. I and II
- e. II and III

20. Which functional group(s) is/are present in the antibiotic, amoxicillin?

- a. ester
- b. anhydride
- c. amide ✓
- d. carboxylic acid ✓
- e. more than one of the above



21. What is the IUPAC name for the following compound?



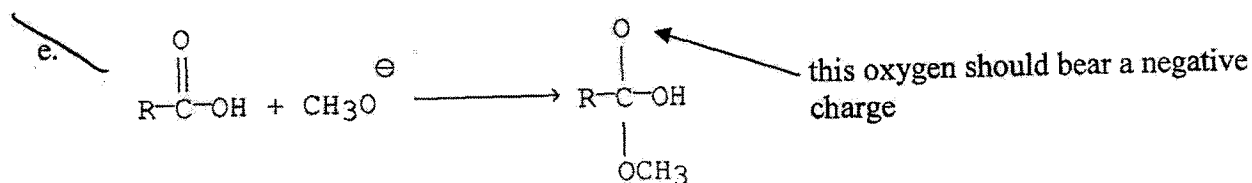
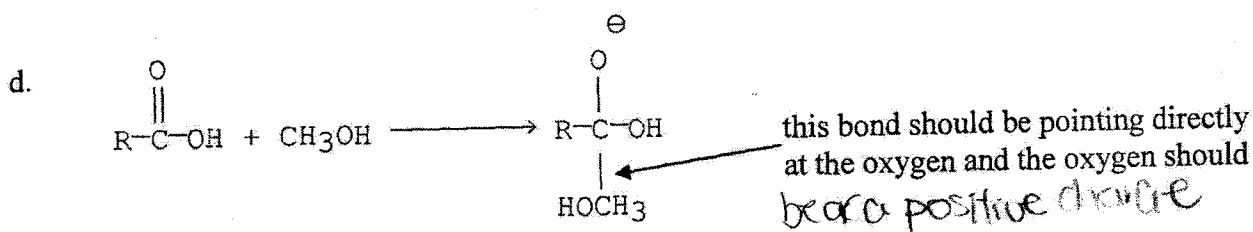
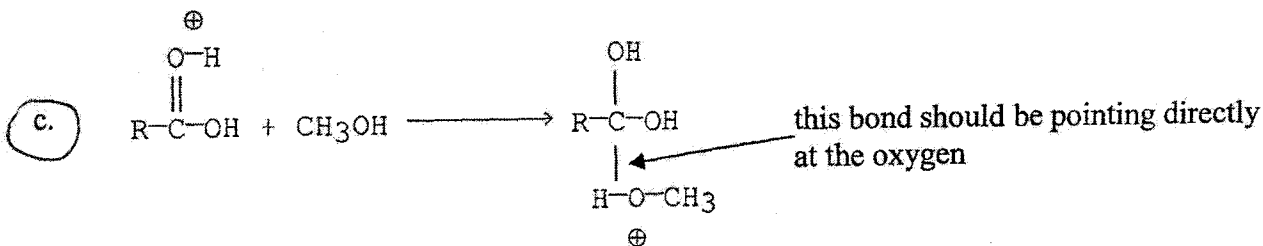
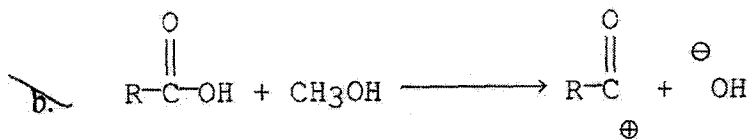
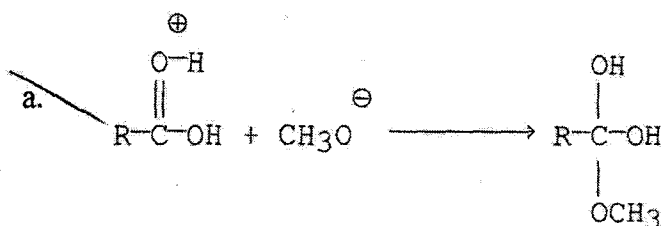
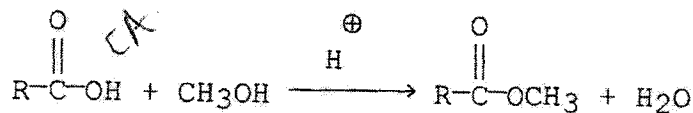
- a. benzyl acetate
- b. methyl benzoate
- c. phenyl ethanoate
- d. benzyl ethanoate
- e. benzyl methylacetate

22. What is the IUPAC name for the following compound: $\overset{3}{\text{F}}\overset{2}{\text{CH}_2}\overset{1}{\text{CH}_2}\text{CONHCH}_2\text{CH}_3$

- ~~a.~~ 1-fluoropentanamide
- ~~b.~~ 1-fluoro-3-pentanamide
- ~~c.~~ ethyl 3-fluoropropanamide
- d. N-ethyl-1-fluoropropanamide
- e.** N-ethyl-3-fluoropropanamide

N

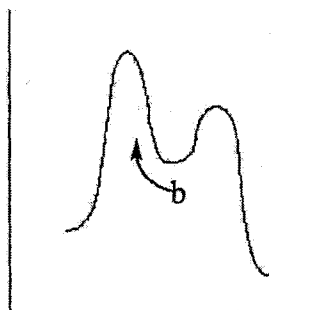
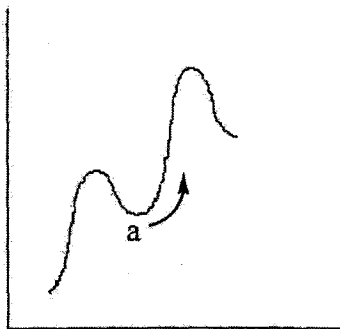
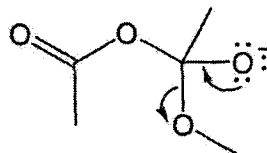
23. Which of the following is one of the steps in the mechanism of the following reaction?



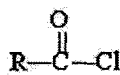
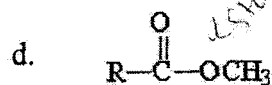
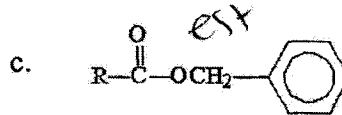
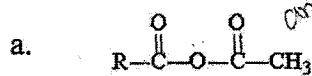
24. The following represents a kinetically *unfavorable* step.

It can be represented by:

- a. step a below only
- b. step b below only
- c. either step a or b below

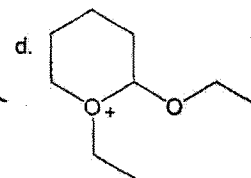
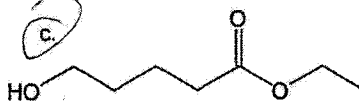
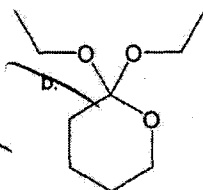
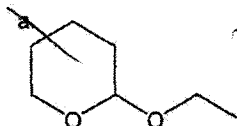
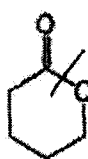


25. Which of the following compounds is hydrolyzed most slowly (if at all) in aqueous NaOH?

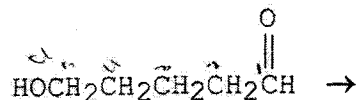


Handwritten notes: "obrating" (circled), "anhydride", "ester", "a d d k e c a c"

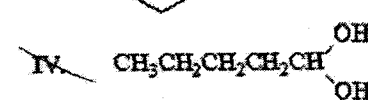
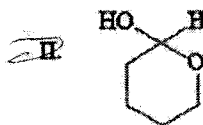
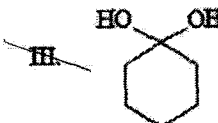
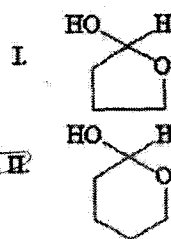
26. Indicate the major product. Note: assume excess ethanol is used.



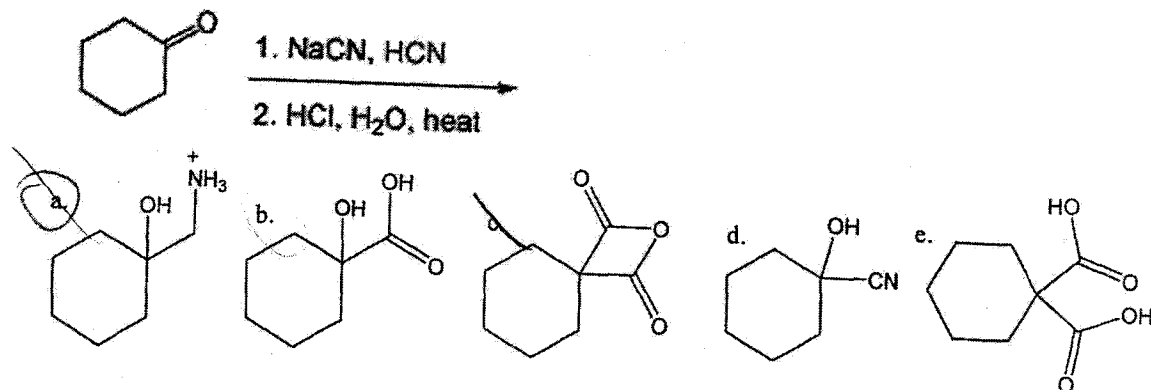
27. The following compound can react with itself (under mild acidic conditions) to form a hemiacetal. Indicate the product.



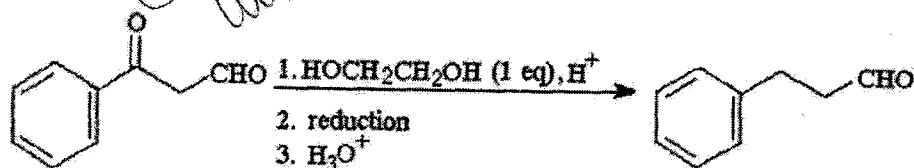
- a. I b. II c. III d. IV e. V



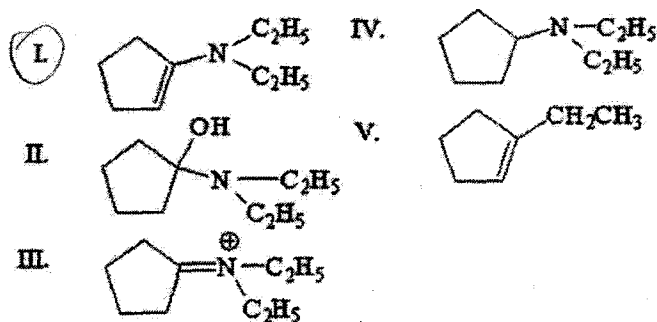
28. Indicate the major product.



27. 29. Which would be most appropriate as the reduction in the following sequence, a Clemmensen (a), Wolff-Kishner (b), or sodium borohydride (c)?



30. Indicate the major product. Assume trace acid present.

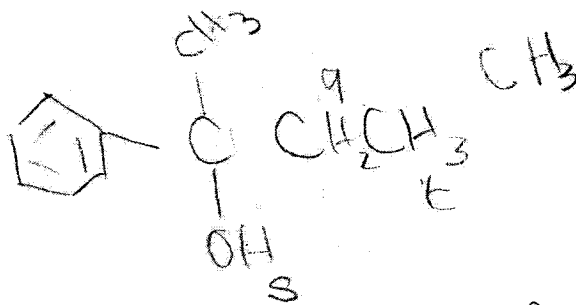
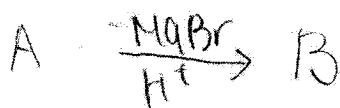
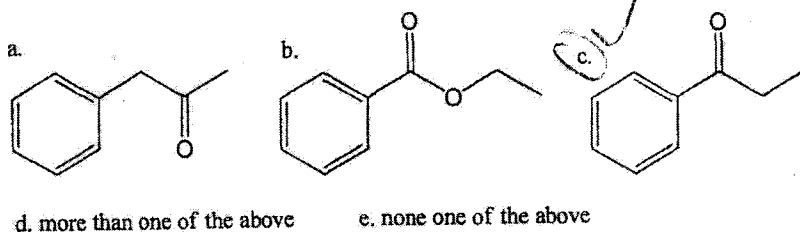


a. I b. II c. III d. IV e. V

31. A compound (or compounds plural) reacts with methylmagnesium bromide followed by acidification to form a product with the following ^1H NMR data. Identify the compound(s). Note again, the NMR is of the product, your job is to identify the starting material(s).

5 marks of answer

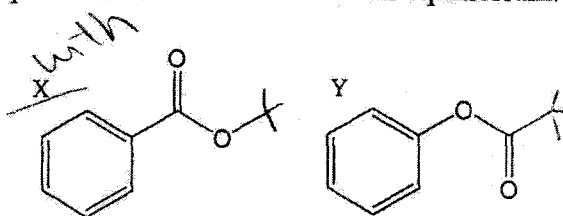
δ	# H	Mult.
0.8	3	triplet ✓
1.6	3	singlet
1.8	2	quartet ✓
1.9	1	singlet
7.2-7.4	5	multiple sigs



32. ^1H NMR data and structures for two esters are shown below. Match each compound to its spectrum and determine which is hydrolyzed more completely when each of the esters is added to an aqueous solution with a pH of 10 and allowed to reach equilibrium.

Spectrum G

δ	# H	Mult.
2.2	3	singlet
7.1-7.4	5	multiple signals

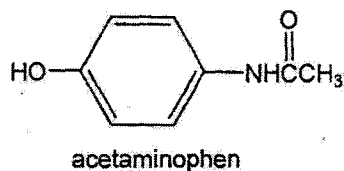


Spectrum H

δ	# H	Mult.
3.9	3	singlet
7.4-8.0	5	multiple signals

- a. X goes with G, Y goes with H, and ~~G~~ is hydrolyzed more
 b. X goes with G, Y goes with H, and ~~H~~ is hydrolyzed more
 c. X goes with H, Y goes with G, and ~~G~~ is hydrolyzed more
 d. X goes with H, Y goes with G, and ~~H~~ is hydrolyzed more

33. Starting from benzene, indicate the preferred synthesis of acetaminophen, the active ingredient in Tylenol.



- a. 1. $\text{H}_2\text{SO}_4, \text{HNO}_3$ 2. H_2, Pd 3. $\text{NaNO}_2, \text{HCl}, 0^\circ\text{C}$ 4. $\text{H}_3\text{O}^+, \Delta$ 5. $\text{H}_2\text{SO}_4, \text{HNO}_3$
 6. separate isomers 7. H_2, Pd 8. ethanoyl chloride
- b. 1. $\text{H}_2\text{SO}_4, \text{HNO}_3$ 2. H_2, Pd 3. ethanoyl chloride 4. $\text{Br}_2, \text{FeBr}_3$ 5. separate isomers 6. NaOH, Δ
- c. 1. $\text{H}_2\text{SO}_4, \text{HNO}_3$ 2. H_2, Pd 3. $\text{H}_2\text{SO}_4, \text{HNO}_3$ 4. separate isomers 5. H_2, Pd
 6. $\text{NaNO}_2, \text{HCl}, 0^\circ\text{C}$ 7. $\text{H}_3\text{O}^+, \Delta$ 8. ethanoyl chloride
- d. 1. ethanamide, AlCl_3 2. $\text{H}_2\text{SO}_4, \text{HNO}_3$ 3. separate isomers 4. H_2, Pd 5. $\text{NaNO}_2, \text{HCl}, 0^\circ\text{C}$ 6. $\text{H}_3\text{O}^+, \Delta$

Your Answer(1- 50): AACDEDDADD DBADECEEDE EECABCBA²⁵AAA CCB
Correct Answer :C...C. D..C...BB. .DA

Possible Points: 33

Number Omitted: 0

Score: 25.0

Number Double Coded: 0

Percent Correct: 75.8

Guessing Penalty: none

Group Number: 1

Seat Number:

Form Number: 1

. =Right, * =Double Mark, - =Omitted, # =Question Dropped, + =Free Question