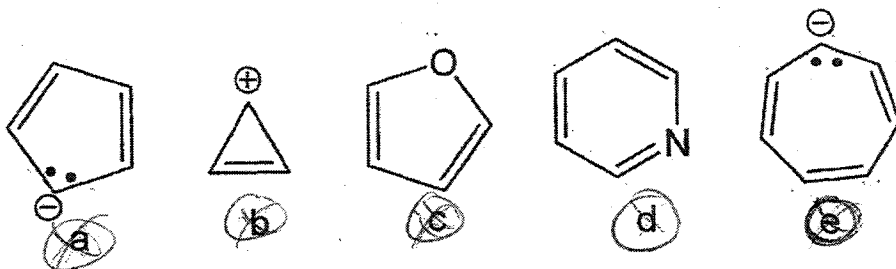


1. Which of the following is not aromatic?



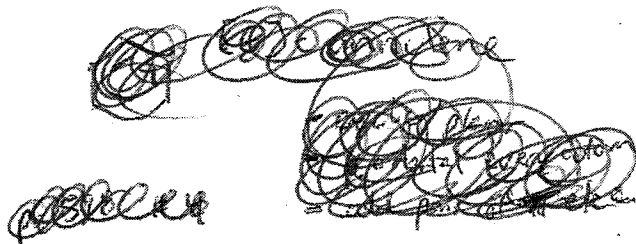
2. Which of the following is aromatic?

- a [8]-Annulene
- b [10]-Annulene
- c [16]-Annulene
- d [18]-Annulene
- e [20]-Annulene



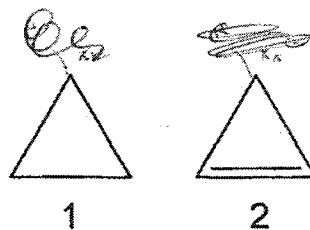
$$4(4) + 2 = 18$$

$$4(5) + 2 = 22$$



3. Which has a lower pKa (ie, is more acidic)?

- a 1
- b 2
- c can not be determined from the information given

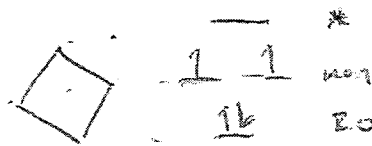
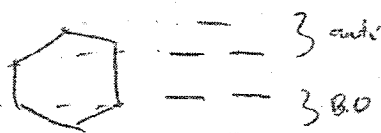


4. Which of the following is true of benzene?

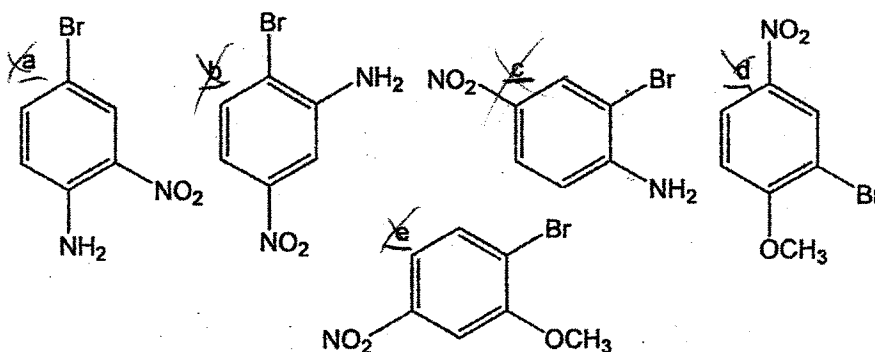
- a It tends to undergo addition rather than substitution reactions.
- b All of its hydrogen atoms are equivalent.
- c Its carbon-carbon bonds are alternately short and long around the ring.
- d The ring is a distorted hexagon.
- e It has the stability expected for theoretical "cyclohexatriene".

5. The π -molecular orbital (MO) diagram of the ground-state of cyclobutadiene supports that it is an _____ molecule, because it has _____.

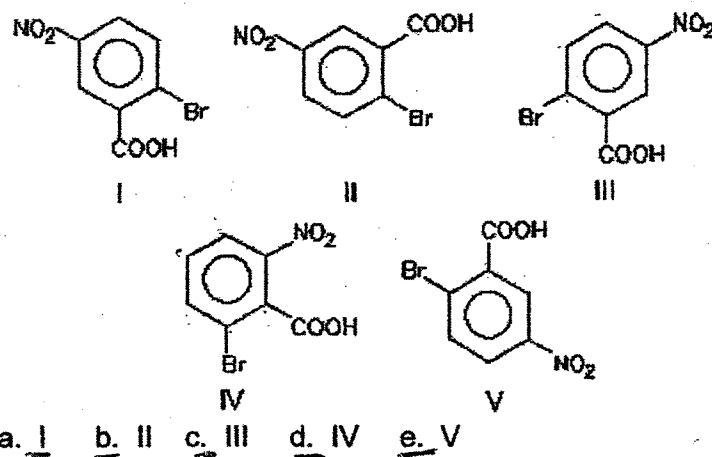
- a aromatic / two unpaired electrons, each residing in degenerate non-bonding MO's
- b aromatic / an electron pair residing in a bonding MO
- c antiaromatic / two unpaired electrons, each residing in degenerate bonding MO's
- d antiaromatic / two electron pairs, each residing in a degenerate non-bonding MO
- e none of the above



6. 2-bromo-4-nitroaniline is:

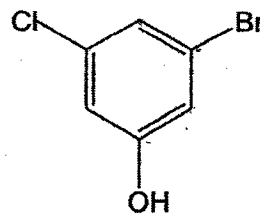


7. Which of the following is not 2-bromo-5-nitrobenzoic acid?

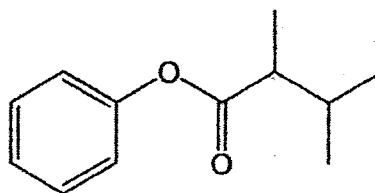


Provide the IUPAC name for the following:

- 8.
- m*-chlorobromo phenol
 - 3-bromo-5-chlorophenol
 - 5-chloro-3-bromophenol
 - 3-chloro-5-bromophenol
 - 5-bromo-3-chlorophenol

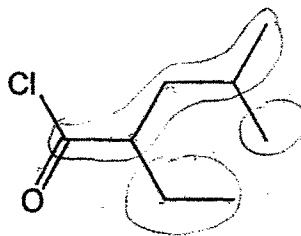


- 9.
- 2,3-dimethylbutylbenzoate
 - benzyl 2,3-dimethylbutanoate
 - 2,3-dimethylbutyl benzoate
 - isoamyl benzoate
 - phenyl 2,3-dimethylbutanoate



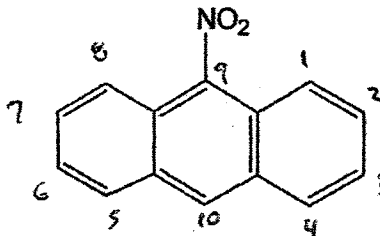
10.

- a. 2-methyl-4-ethylpentanoyl chloride
- b. 3-chloromethanoyl-2-methylhexane
- c. isooctanoyl chloride
- d. 2-ethyl-4-methylpentanoyl chloride
- e. none of the above



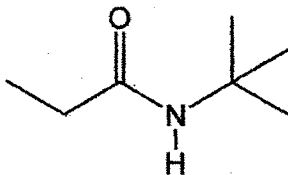
11.

- a. 6-aminoanthracene
- b. 6-aminoaphenanthrene
- c. 9-nitroanthracene
- d. 9-nitrophenanthrene
- e. 6-nitronaphthalene



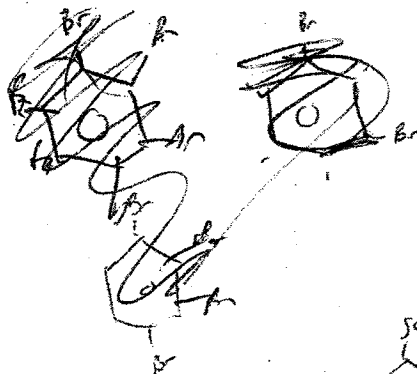
12. The molecule shown is best classified as a:

- a. 1° amide
- b. 2° amide
- c. 3° amide
- d. mixed anhydride
- e. none of the above

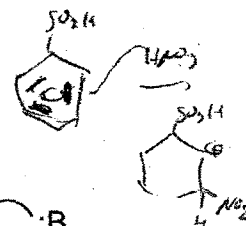
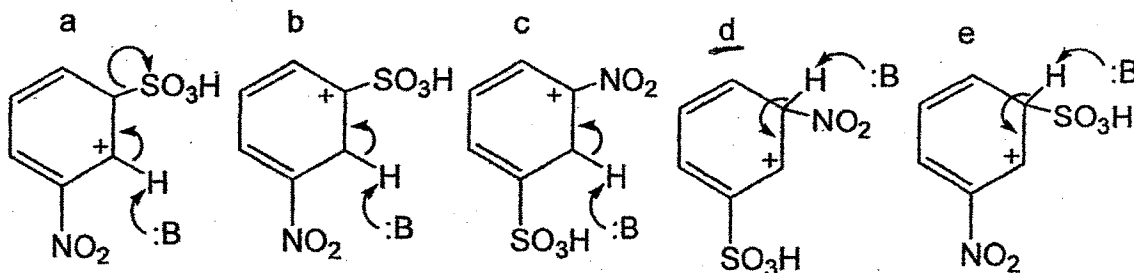


13. Which dibromobenzene can, in theory, yield three mononitro derivatives? For this question, do not be concerned about yields; assume all potential isomers would be formed to some extent.

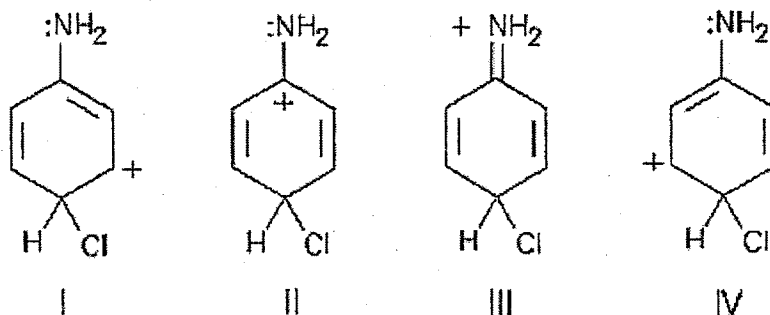
- a. o-dibromobenzene
- b. m-dibromobenzene
- c. p-dibromobenzene
- d. all of these
- e. none of these



14. The final mechanistic step in the nitration of benzenesulfuonic acid is:

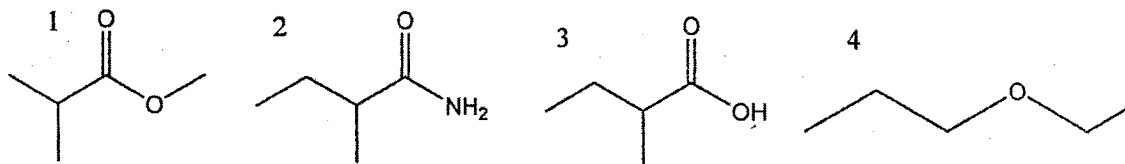


15. Which would be an especially stable contributor to the resonance stabilized hybrid formed when aniline undergoes para-chlorination?



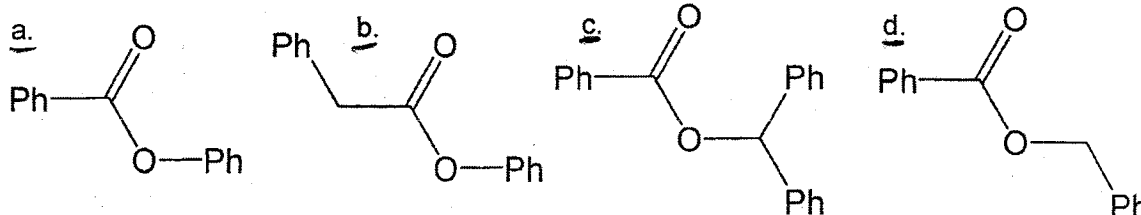
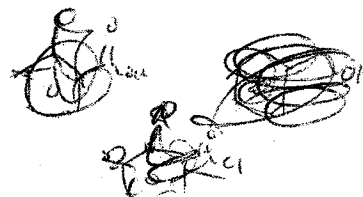
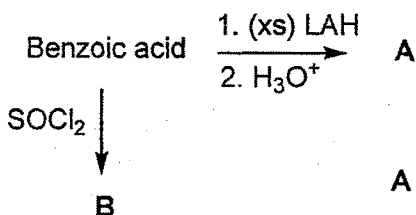
- I
 II
 III
 IV
 None of these

16. Rank the following from highest expected boiling point to lowest. Assume all have approximately the same molecular weight.



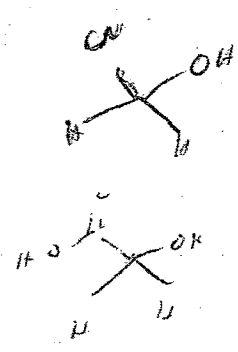
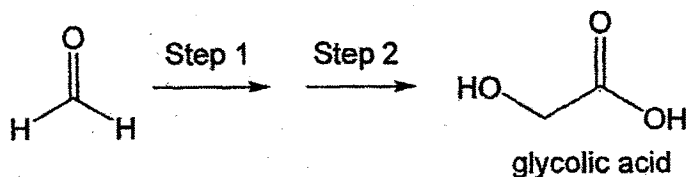
- 1 > 2 > 3 > 4
 3 > 2 > 1 > 4
 4 > 3 > 1 > 2
 2 > 3 > 1 > 4
 none of the above

17. Benzoic acid can be independently converted into products A and B as shown. What product, C, would be formed by the reaction of A and B?



e. None of the above

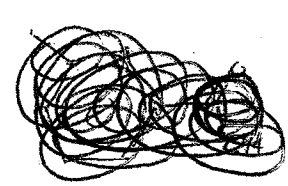
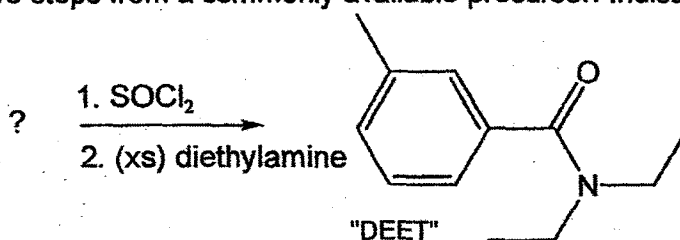
18. The α -hydroxy acid, glycolic acid, shown below, is widely used in the cosmetics industry as a facial skin rejuvenator. It can be synthesized from formaldehyde (methanal) in two steps. Indicate the steps.



	Step 1	Step 2
a.	1. CH_3MgBr 2. H_3O^+	$\text{Na}_2\text{Cr}_2\text{O}_7$
b.	1. NaBH_4 2. H_3O^+	$\text{CH}_3\text{OH}, \text{H}^+$
c.	(xs) NaCN, HCl	$\text{HCl}, \text{H}_2\text{O}, \Delta$
d.	$\text{HOCH}_2\text{OH}, \text{H}^+$	H_2, Pt

e. None of the above

19. DEET (shown below), the active ingredient in most insect repellents, can be readily synthesized in two steps from a commonly available precursor. Indicate the precursor.



- a. *m*-methylbenzoic acid
- b. *m*-bromotoluene
- c. *N,N*-diethylbenzamide
- d. *m*-methylaniline
- e. *N,N*-diethylbenzoic anhydride

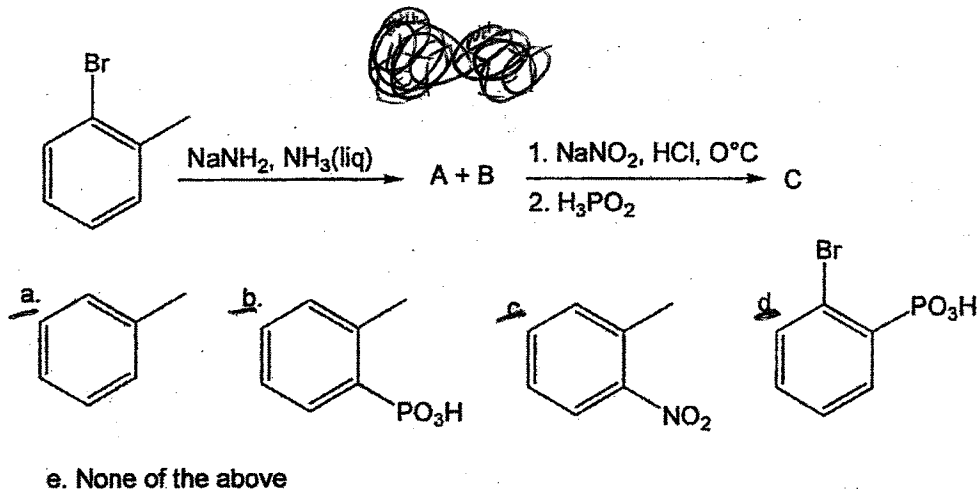
20. Which would be a good synthesis of *m*-nitrobenzoic acid?

- ~~A~~ Benzene $\xrightarrow[\text{heat}]{\text{HNO}_3/\text{H}_2\text{SO}_4}$ $\xrightarrow[\text{AlCl}_3]{\text{CH}_3\text{Cl}}$ $\xrightarrow[(2) \text{H}_3\text{O}^+]{(1) \text{KMnO}_4, \text{OH}^-, \text{heat}}$
- ~~B~~ Toluene $\xrightarrow[\text{heat}]{\text{HNO}_3/\text{H}_2\text{SO}_4}$ $\xrightarrow[(2) \text{H}_3\text{O}^+]{(1) \text{KMnO}_4, \text{OH}^-, \text{heat}}$
- ~~C~~ Toluene $\xrightarrow[(2) \text{H}_3\text{O}^+]{(1) \text{KMnO}_4, \text{OH}^-, \text{heat}}$ $\xrightarrow[\text{heat}]{\text{HNO}_3/\text{H}_2\text{SO}_4}$

- ~~D~~ More than one of the above
- ~~E~~ None of the above

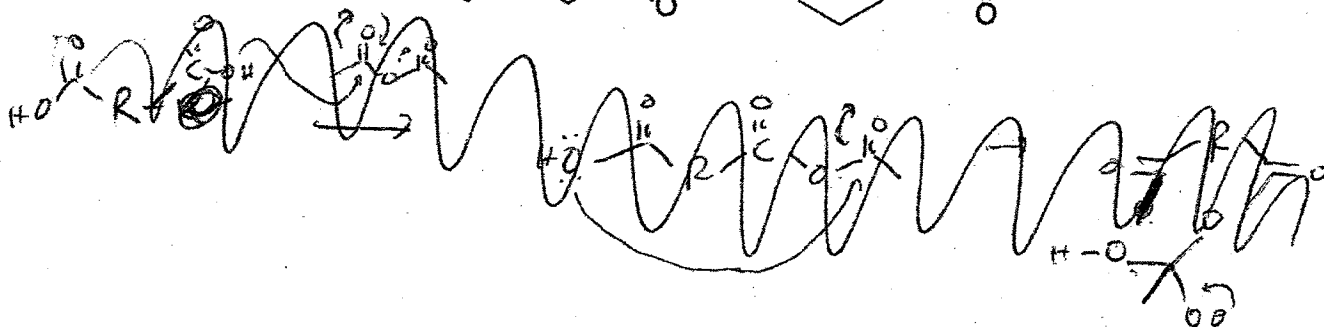
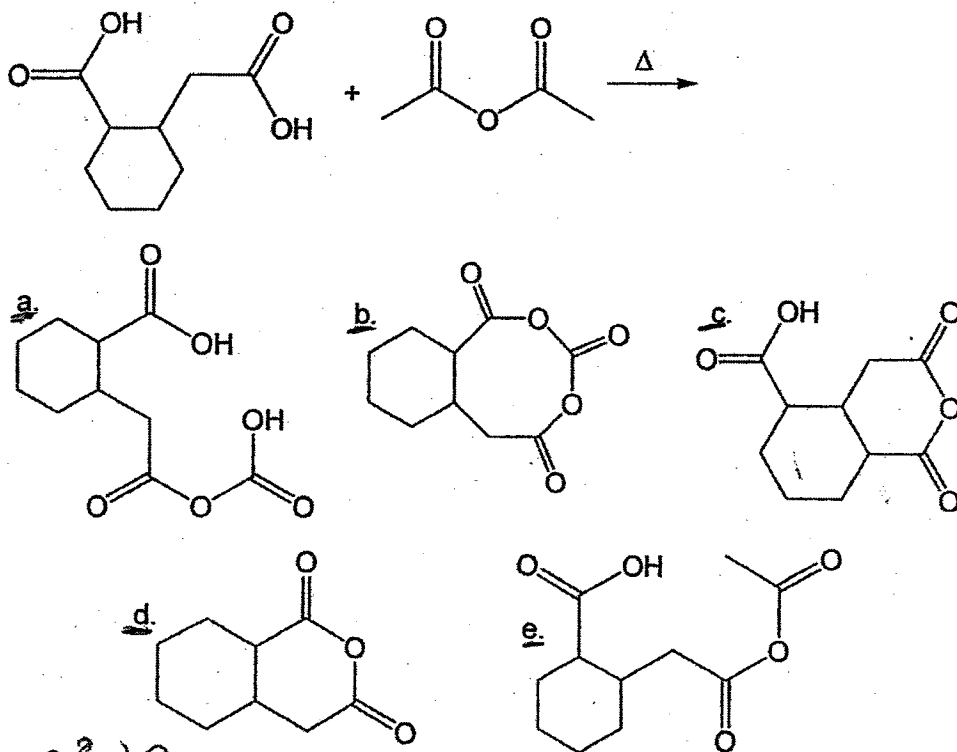


21. Identify the final product C in the following synthetic scheme.

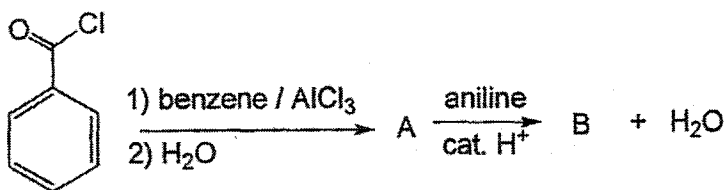


22. Identify the reaction product.

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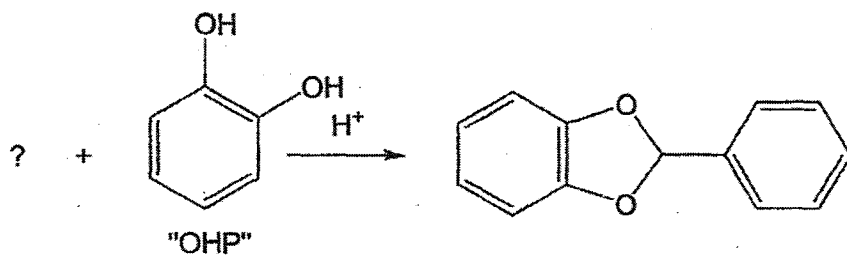
23. Identify product B in the following scheme.



- a.
 b.
 c.
 d.

 e. None of the above

24. *o*-hydroxyphenol ("OHP") can be used as an acetalizing agent analogously to how ethane-1,2-diol is used. Indicate the starting material in the following transformation.

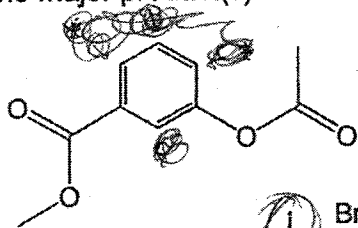


- a.
 b.
 c.
 d.
 e.

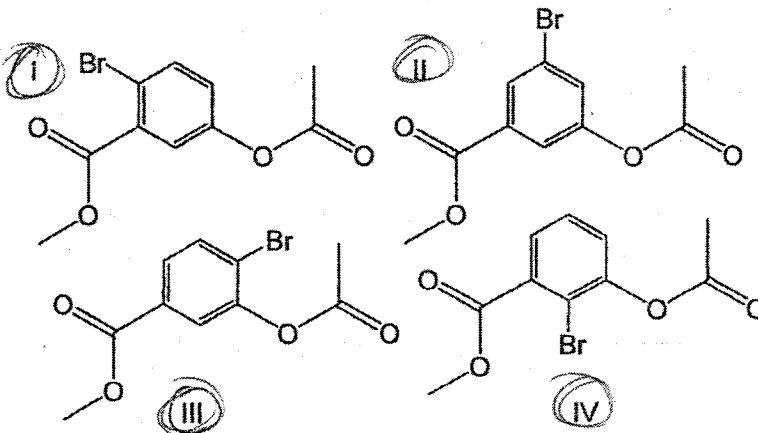
25. Which of the following is not an ortho-para director in electrophilic aromatic substitution?

- A) $-\text{CF}_3$
 B) $-\text{OCH}_3$
 C) $-\text{CH}_3$
 D) $-\text{F}$
 E) $-\text{NH}_2$

26. Indicate the major product(s).

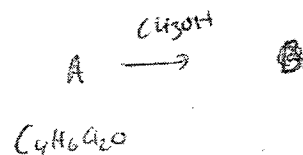


- a. I
- b. II
- c. III
- d. IV
- e. More than one of these

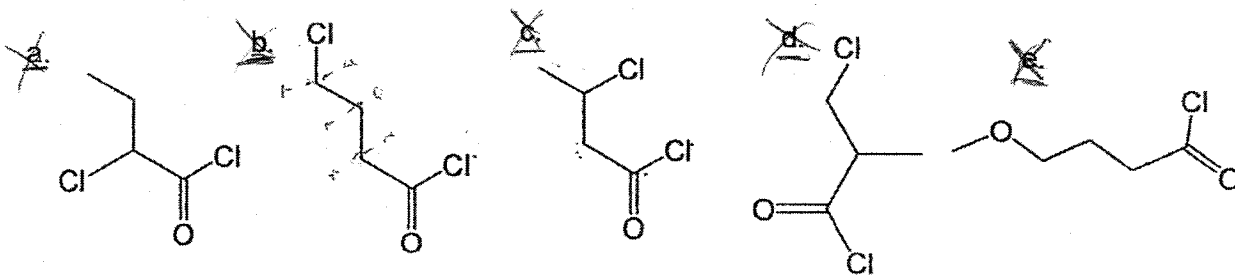


27. When treated with an equivalent of methanol, compound A, with molecular formula $C_4H_6Cl_2O$, forms compound B, whose 1H NMR data is shown below. Identify compound A.

Compound B NMR			
δ	Approximate integration (mm)	# hydrogens	splitting
2.1	8	2	multiplet
2.5	8	2	triplet
3.6	8	2	triplet
3.7	11	3	singlet

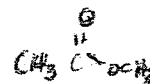


Identify compound A.

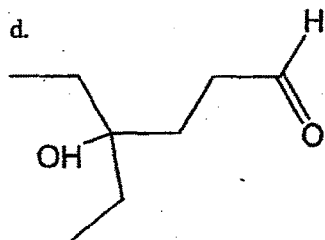
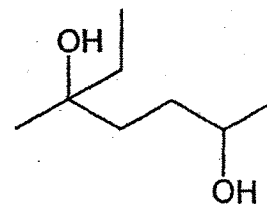
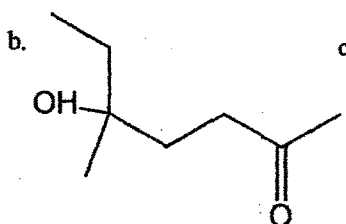
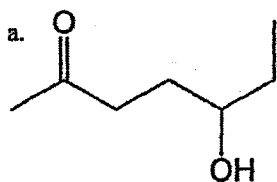
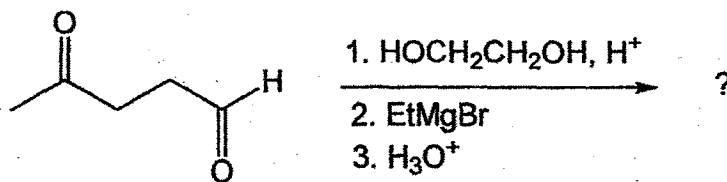


28. Which of the following is a true statement regarding the acid-catalyzed (AC) and base-promoted (BP) hydrolyses of methyl ethanoate (methyl acetate)?

- a. In the AC case, methoxide leaves and in the BP case, methanol leaves
- b. In the AC case, acid is consumed and in the BP case, base is regenerated
- c. In the AC case, the carboxylate is formed, and in the BP case, the carboxylic acid is formed.
- d. In both the AC and BP cases, methanol is produced
- e. None of the above



29. Indicate the major product.



e. None of the above

CHM 202 Heller Test 2 Spring 2006 Answer Key

1. E
2. D
3. A
4. B
5. E
6. C
7. D
8. B
9. E
10. D
11. C
12. B
13. B
14. D
15. C
16. D
17. D
18. C
19. A
20. C
21. A
22. D
23. B
24. C
25. A
26. E
27. B
28. D
29. A