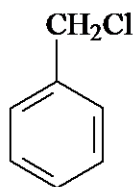
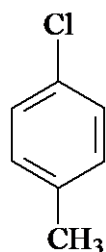


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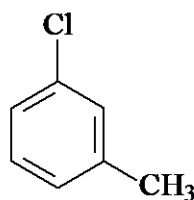
1. Which one of the following has the weakest carbon-chlorine bond?



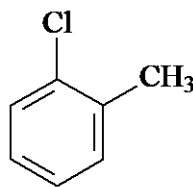
I



II



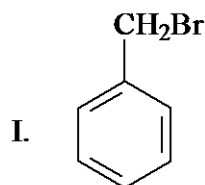
III



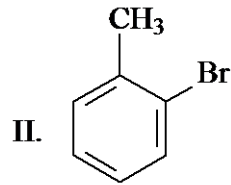
IV

- A. I
- B. II
- C. III
- D. IV

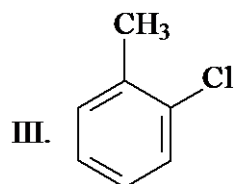
2. Which compound in each of the following pairs is the most reactive to the conditions indicated?



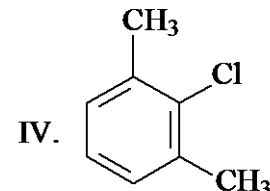
and



(KOH in CH_3OH)



and



(NaNH_2 in NH_3)

- A. I and III
- B. I and IV
- C. II and III
- D. II and IV

3. Which of the following reacts at the fastest rate with potassium methoxide (KOCH_3) in methanol?

- A. fluorobenzene
- B. 4-nitrofluorobenzene
- C. 2,4-dinitrofluorobenzene
- D. 2,4,6-trinitrofluorobenzene

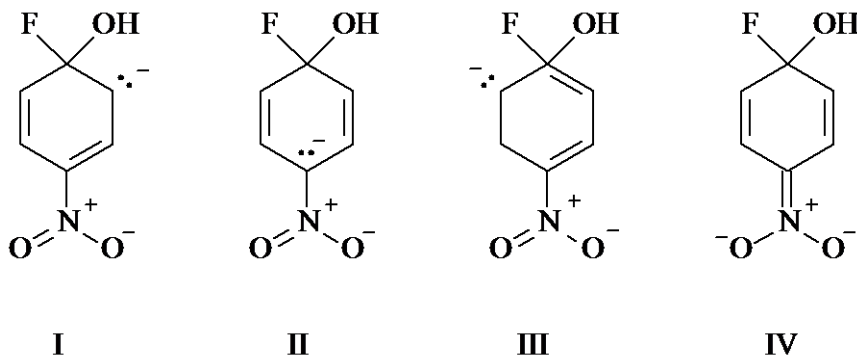
4. Which of the following reacts at the fastest rate with potassium methoxide (KOCH_3) in methanol?

- A. fluorobenzene
- B. *p*-nitrofluorobenzene
- C. *p*-fluorotoluene
- D. *p*-bromofluorobenzene

5. Which of the following is the kinetic rate equation for the addition-elimination mechanism of nucleophilic aromatic substitution?

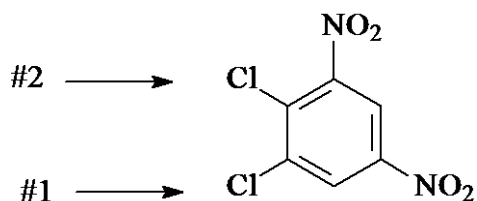
- A. rate = $k[\text{aryl halide}]$
- B. rate = $k[\text{nucleophile}]$
- C. rate = $k[\text{aryl halide}][\text{nucleophile}]$
- D. rate = $k[\text{aryl halide}][\text{nucleophile}]^2$

6. Which of the following is not a resonance form of the intermediate in the nucleophilic addition of hydroxide ion to *para*-fluoronitrobenzene?



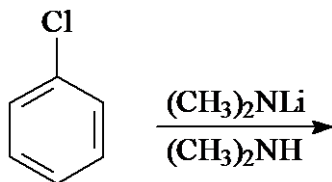
- A. I
- B. II
- C. III
- D. IV

7. Which chlorine is most susceptible to nucleophilic substitution with NaOCH_3 in methanol?



- A. #1
- B. #2
- C. #1 and #2 are equally susceptible
- D. no substitution is possible

8. What is the product of the following reaction?

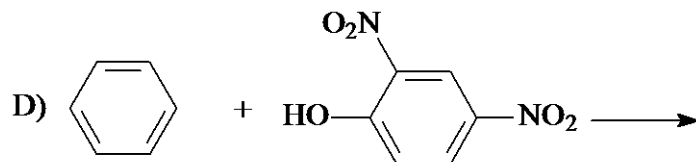
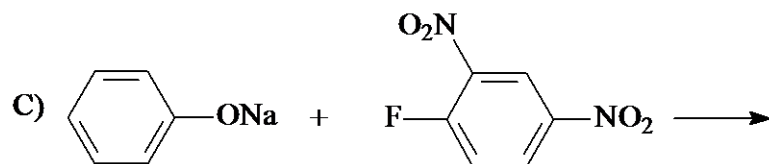
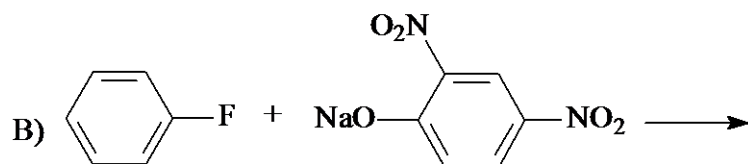
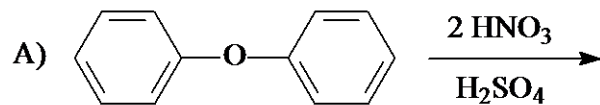
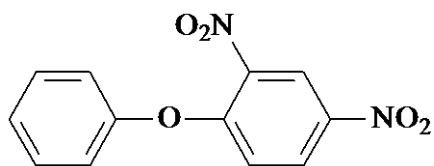


- A. *N,N*-dimethylaniline
- B. *para*-chloro-*N,N*-dimethylaniline
- C. phenyllithium ($\text{C}_6\text{H}_5\text{Li}$)
- D. *meta*-chloro-*N,N*-dimethylaniline

9. Which one of the reagents readily reacts with bromobenzene without heating?

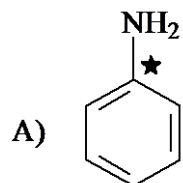
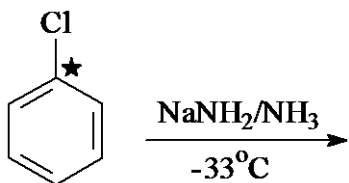
- A. $\text{NaOCH}_2\text{CH}_3$
- B. NaCN/DMSO
- C. $\text{NaNH}_2/\text{NH}_3$
- D. $(\text{CH}_3)_2\text{NH}$

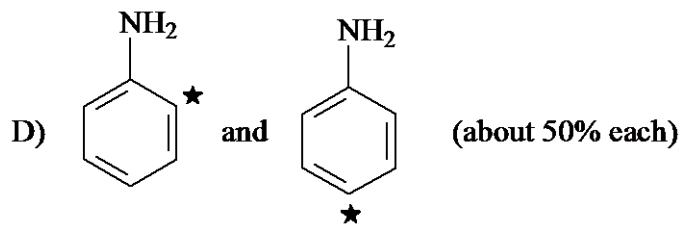
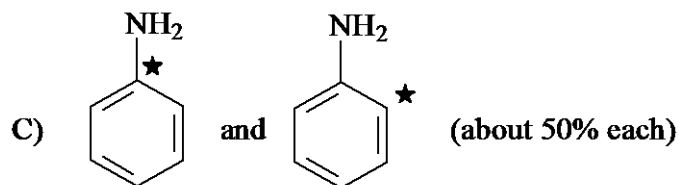
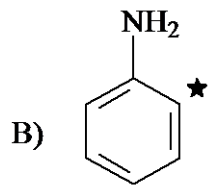
10. Which of the following would work best for the synthesis of the ether shown below?



- A. A
B. B
C. C
D. D

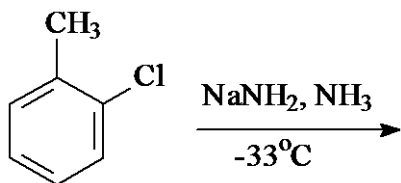
11. Carbon-14 labelled chlorobenzene is reacted with sodium amide in ammonia as shown below. Which of the following depicts the carbon-14 label in the product(s)?





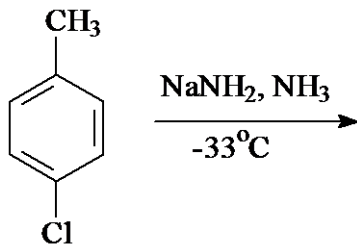
- A. A
B. B
C. C
D. D

12. Identify the product(s) of the following reaction.



- A. only *ortho*-methylaniline
B. *ortho*-methylaniline and *meta*-methylaniline
C. *meta*-methylaniline and *para*-methylaniline
D. *ortho*-methylaniline and *para*-methylaniline

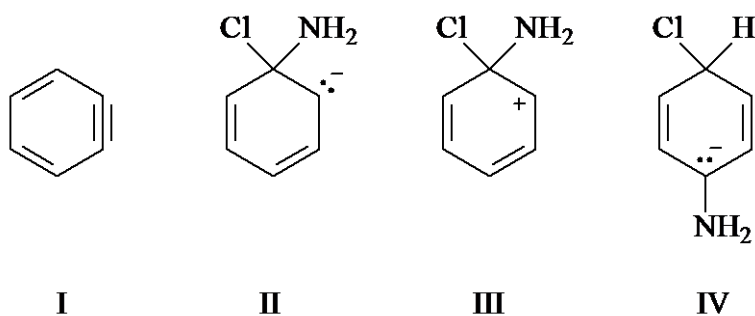
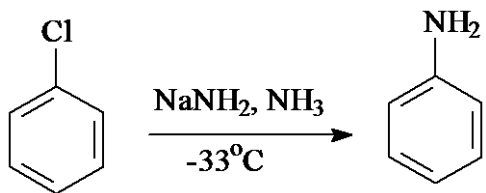
13. Which of the following best estimates the percentages of the three isomeric methylanilines from the reaction shown below?



- | | <u><i>ortho</i>-methylaniline</u> | <u><i>meta</i>-methylaniline</u> | <u><i>para</i>-methylaniline</u> |
|--------|-----------------------------------|----------------------------------|----------------------------------|
| A) 33% | 33% | 33% | 33% |
| B) 40% | 40% | 20% | 20% |
| C) 0% | 50% | 50% | 0% |
| D) 0% | 66% | 33% | 0% |

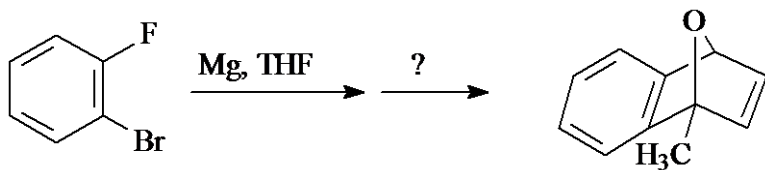
- A. A
- B. B
- C. C
- D. D

14. Which of the following is a key intermediate in the reaction shown below?

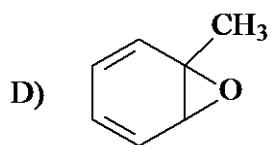
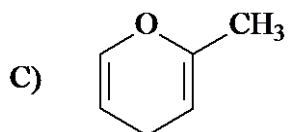


- A. I
- B. II
- C. III
- D. IV

15. Identify the diene required for the synthesis shown below.

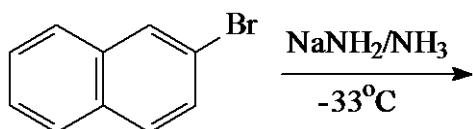


- A) Cc1ccoc1
- B) Cc1ccoc1



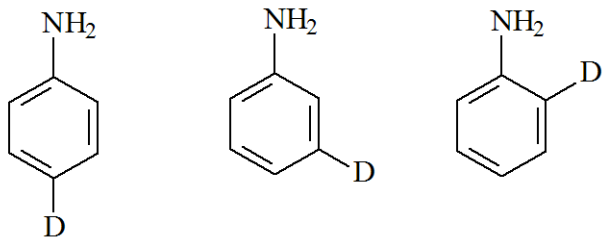
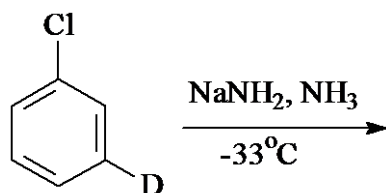
- A. A
B. B
C. C
D. D

16. Assume that the following reaction goes by the elimination-addition mechanism for nucleophilic aromatic substitution. Based on that, how many isomeric naphthylamines are expected in the following reaction?



- A. only a single product
B. two
C. three
D. four

17. Which of the following best estimates the percentages of the three isomeric deuterated anilines from the reaction shown below?



- | | | |
|--------|-----|-----|
| A) 25% | 50% | 25% |
| B) 33% | 33% | 33% |
| C) 50% | 25% | 25% |
| D) 66% | 33% | 0% |

- A. A
B. B
C. C

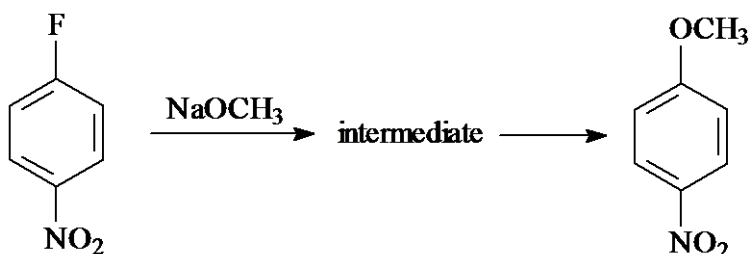
D. D

18. Which of the following is(are) true concerning the intermediate benzyne?

- I. Benzyne is aromatic.
- II. All the hydrogens of benzyne are equivalent and indistinguishable.
- III. The benzyne molecule has strain energy.

- A. only I
- B. only III
- C. I and III
- D. II and III

19. Which of the following is(are) true concerning the intermediate in the addition-elimination mechanism of the reaction below?



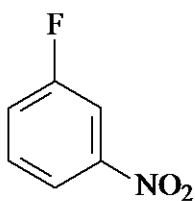
- I. The intermediate is aromatic.
- II. The intermediate is a resonance stabilized anion.
- III. Electron withdrawing groups on the benzene ring stabilize the intermediate.

- A. only I
- B. only II
- C. I and III
- D. II and III

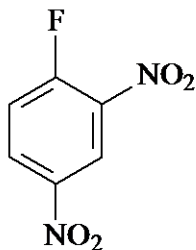
20. Which one of the following has the fastest rate of reaction with sodium ethoxide, NaOCH₂CH₃, at 25°C?

- A. *para*-fluoronitrobenzene
- B. *para*-chloronitrobenzene
- C. *para*-bromonitrobenzene
- D. *para*-iodonitrobenzene

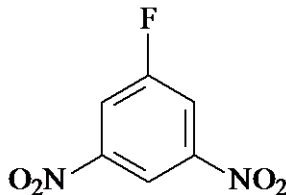
21. Arrange the following compounds in order of increasing reactivity with sodium methoxide, NaOCH₃?



I



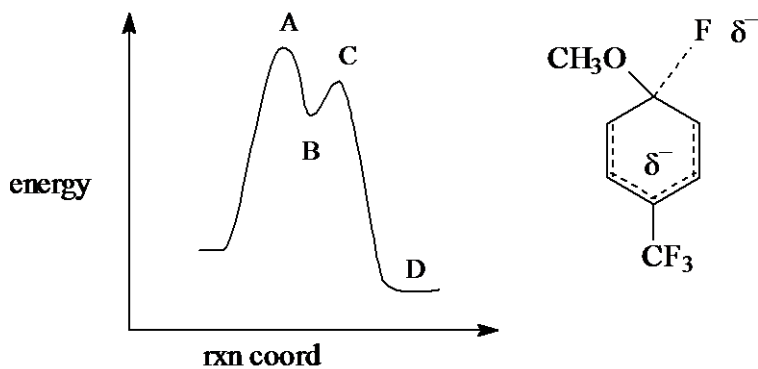
II



III

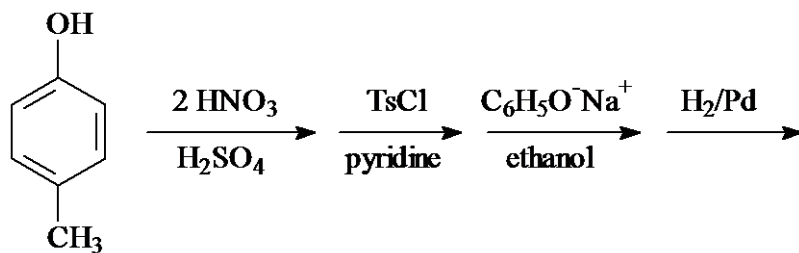
- A. I < II < III
- B. I < III < II
- C. II < I < III
- D. III < II < I

22. Which position on the potential energy diagram corresponds to the species shown for the reaction of *para*-fluoro (trifluoromethyl) benzene with sodium methoxide?

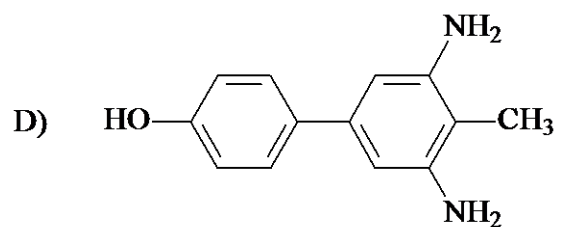


- A. A
B. B
C. C
D. D

23. Which of the following is the product from the reaction sequence shown below?

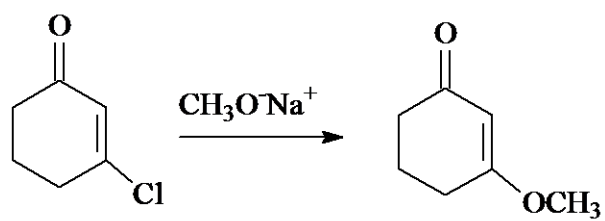


- A)
- B)
- C)



- A. A
- B. B
- C. C
- D. D

24. Identify the likely mechanism in the reaction shown below.



- A. S_N2
- B. S_N1
- C. electrophilic addition-elimination
- D. nucleophilic addition-elimination

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