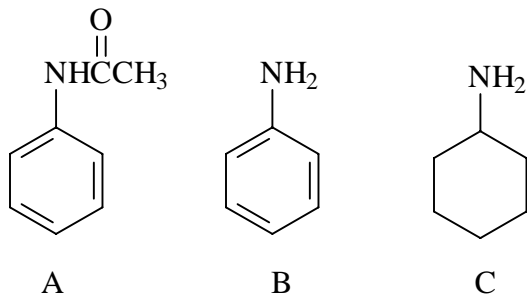


1. To convert a nitrile to a primary amine you must:
- A) hydrolyze it with water.
  - B) oxidize it with chromic acid.
  - C) reduce it with hydrogen or lithium aluminum hydride.
  - D) substitute it with an alkyl halide.

2. Rank the following three compounds in decreasing order of basicity.

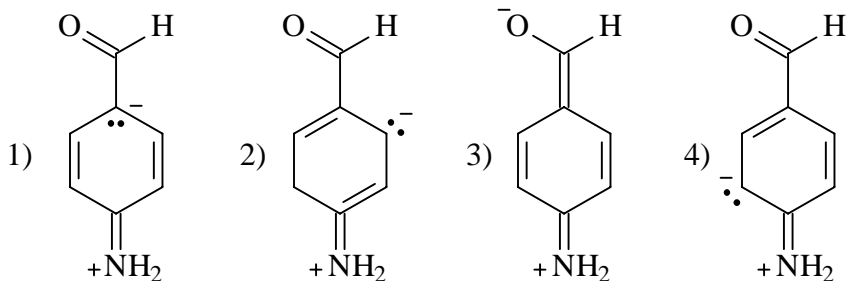


- A) C>A>B
- B) C>B>A
- C) B>A>C
- D) B>C>A

3. Which one of the following amines gives an *N*-nitrosoamine on treatment with nitrous acid, HNO<sub>2</sub>?

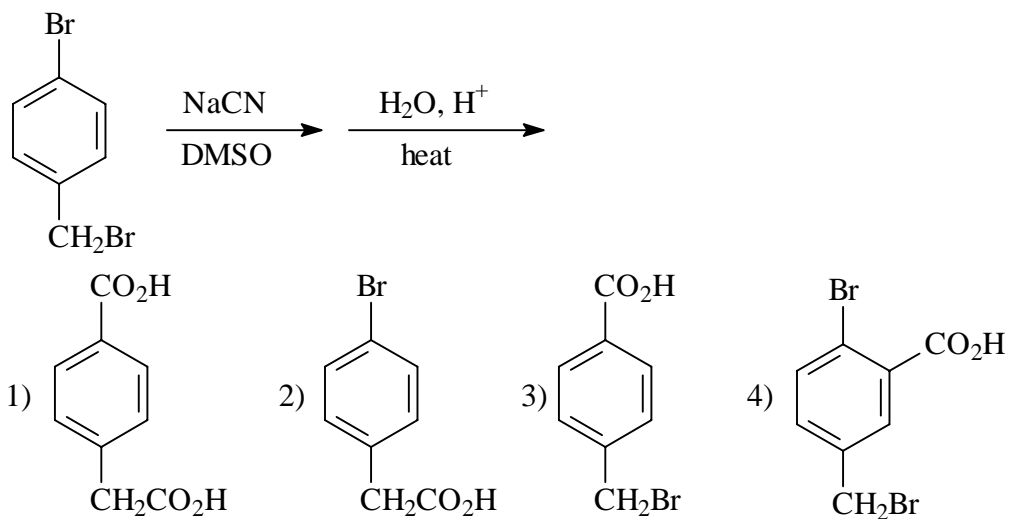
- A) 2,4-dimethylaniline
- B) 3,5-dimethylaniline
- C) *N*,4-dimethylaniline
- D) *N,N*-dimethylaniline

4. Which one of the following is not a resonance form of *para*-aminobenzaldehyde?



- A) is 1
- B) is 2
- C) is 3
- D) is 4

5. Which one of the following would not give an appreciable yield of Claisen condensation product?
- A) ethyl hexanoate  
 B) ethyl 2-methylhexanoate  
 C) ethyl 3-methylhexanoate  
 D) ethyl 4-methylhexanoate
6. How many different Claisen condensation products are possible in the reaction of equal amounts of ethyl acetate ( $\text{CH}_3\text{CO}_2\text{Et}$ ) and ethyl propanoate ( $\text{CH}_3\text{CH}_2\text{CO}_2\text{Et}$ )?
- A) only one  
 B) two  
 C) three  
 D) four
7. What is the product of the reaction shown below?

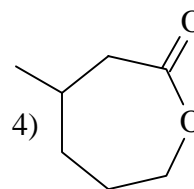
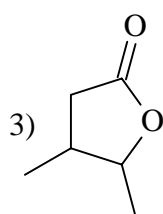
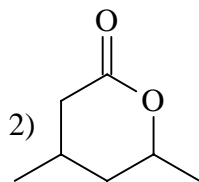
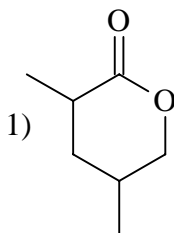
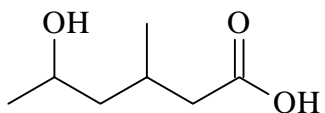


- A) is 1  
 B) is 2  
 C) is 3  
 D) is 4

8. Which of the following is the strongest acid?

- A)  $\text{FCH}_2\text{CO}_2\text{H}$
- B)  $\text{ClCH}_2\text{CO}_2\text{H}$
- C)  $\text{BrCH}_2\text{CO}_2\text{H}$
- D)  $\text{ICH}_2\text{CO}_2\text{H}$

9. Identify the lactone formed by the following hydroxy carboxylic acid.



- A) is 1
- B) is 2
- C) is 3
- D) is 4

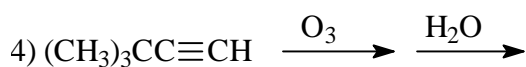
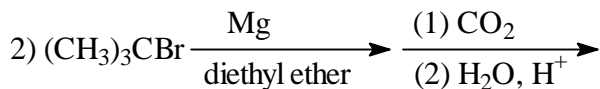
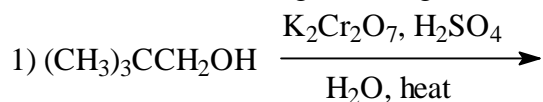
10. Which one of the following has the best soap cleansing properties?

- A)  $\text{CH}_3(\text{CH}_2)_{16}\text{CO}_2\text{H}$
- B)  $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- C)  $\text{CH}_3(\text{CH}_2)_{16}\text{CO}_2\text{Na}$
- D)  $\text{CH}_3\text{CH}_2\text{CO}_2\text{Na}$

11. Which of the following has the largest acid equilibrium constant,  $K_a$ ?

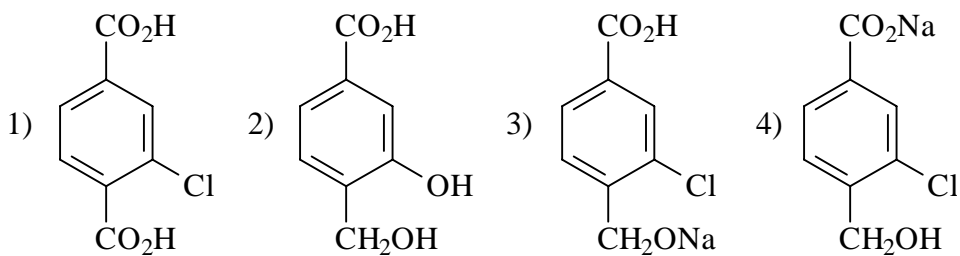
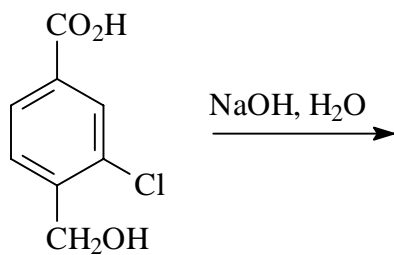
- A) benzoic acid
- B) *ortho*-nitrobenzoic acid
- C) *para*-methylbenzoic acid (*para*-toluic acid)
- D) *para*-methoxybenzoic acid

12. Which of the following is not a good method to make 2,2-dimethylpropanoic acid?



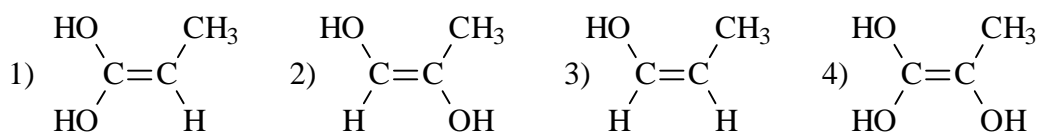
- A) is 1  
 B) is 2  
 C) is 3  
 D) is 4

13. What is the product of the reaction shown below?



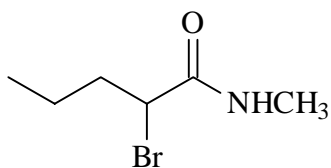
- A) is 1  
 B) is 2  
 C) is 3  
 D) is 4

14. Which of the following is the enol intermediate in the thermal decarboxylation of methylpropanedioic acid,  $\text{CH}_3\text{CH}(\text{CO}_2\text{H})_2$ ?



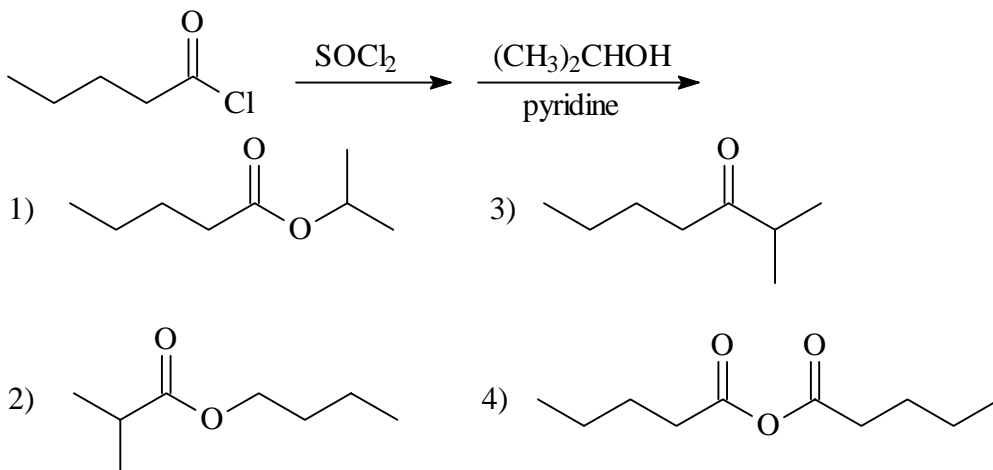
- A) is 1  
 B) is 2  
 C) is 3  
 D) is 4

15. What is the name of the compound shown below?



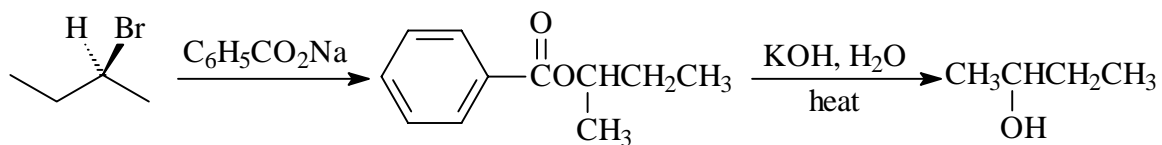
- A) 2-bromo-*N*-methylpentamide  
 B) 2-bromo(methylamino)pentamide  
 C) methylamino 2-bromopentamide  
 D) methyl 2-bromopentamide

16. What is the product of the following reactions?



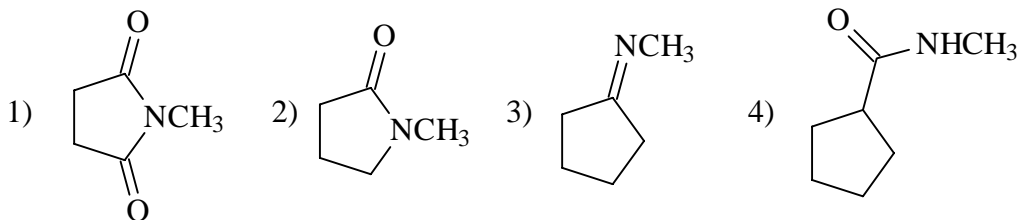
- A) is 1  
 B) is 2  
 C) is 3  
 D) is 4

17. Identify the stereochemistries of *sec*-butyl benzoate and 2-butanol in the following reaction sequence? (Assume that the reaction sequence shown follows the customary mechanisms for bimolecular nucleophilic substitution and nucleophilic acyl substitution.)



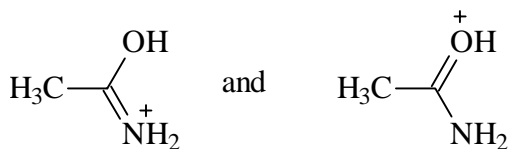
- |            | <i>sec</i> -butyl benzoate | 2-butanol |
|------------|----------------------------|-----------|
| A) R       | S                          |           |
| B) R       | R                          |           |
| C) S       | R                          |           |
| D) S       | racemic                    |           |
| E) racemic | racemic                    |           |

18. Each of the following gives methylammonium chloride,  $\text{CH}_3\text{NH}_3^+ \text{Cl}^-$ , when hydrolyzed in aqueous acid solution except one. Which one?



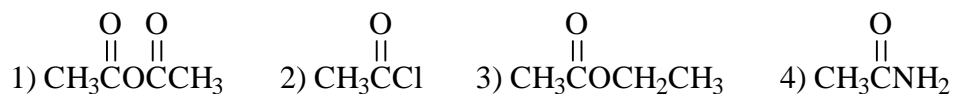
- A) is 1  
 B) is 2  
 C) is 3  
 D) is 4

19. What is the relationship between the following two structures?



- A) resonance forms  
 B) stereoisomers  
 C) constitutional isomers  
 D) tautomers

20. Which of the following has the fastest rate of hydrolysis to give acetic acid?

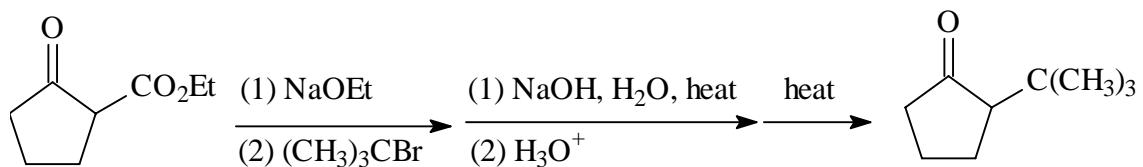


- A) is 1  
B) is 2  
C) is 3  
D) is 4

21. Which of the following would work best in preparing *tert*-butyl benzoate?

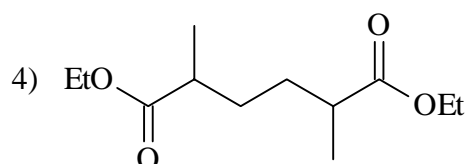
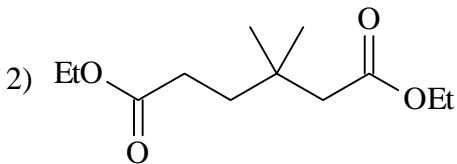
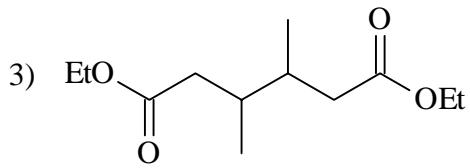
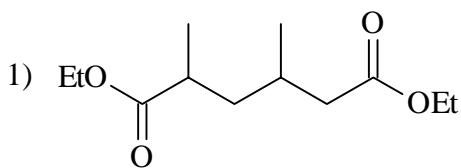
- A)  $\text{C}_6\text{H}_5\text{CO}_2\text{H}$  plus  $(\text{CH}_3)_3\text{COH}$  with  $\text{H}_2\text{SO}_4$  catalyst and heat  
B)  $\text{C}_6\text{H}_5\text{CO}_2\text{Na}$  plus  $(\text{CH}_3)_3\text{CBr}$  and heat  
C)  $\text{C}_6\text{H}_5\text{CONH}_2$  plus  $(\text{CH}_3)_3\text{COH}$  and heat  
D)  $\text{C}_6\text{H}_5\text{CO}_2\text{H}$  plus  $\text{SOCl}_2$  followed by  $(\text{CH}_3)_3\text{COH}$  with pyridine

22. Consider the following synthetic scheme below. Which of the following best explains why the synthesis does not work?



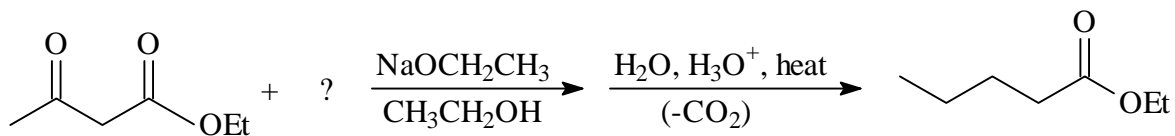
- A) Using  $\text{NaOEt}$  gives Claisen condensation instead of alkylation.  
B) The alkyl halide used will lead to elimination rather than alkylation.  
C) The keto-acid formed does not decarboxylate in the last step.  
D) The base-promoted hydrolysis step does not work on the  $\beta$ -keto ester intermediate.

23. Which one of the following would not be expected to give a significant yield in a Dieckmann condensation?



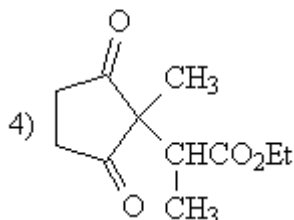
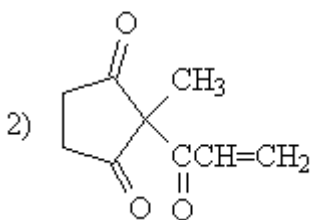
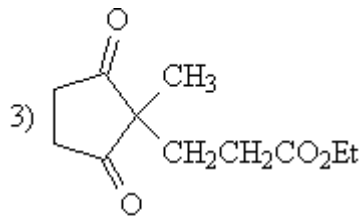
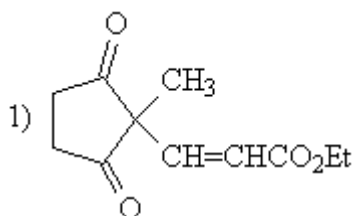
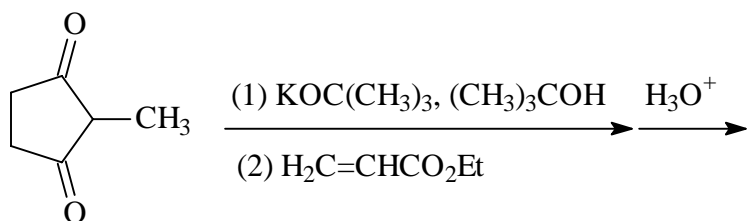
- A) is 1  
 B) is 2  
 C) is 3  
 D) is 4

24. Which of the following could be used as the missing reagent to carry out the following transformation?



- A)  $\text{CH}_3\text{CH}=\text{O}$   
 B)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$   
 C)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$   
 D)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{I}$

25. Which of the following is the Michael addition product of the reaction below?



- A) is 1
- B) is 2
- C) is 3
- D) is 4

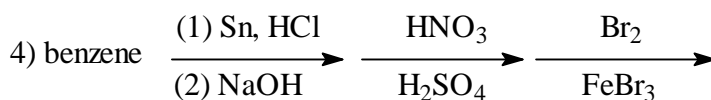
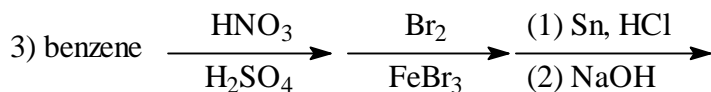
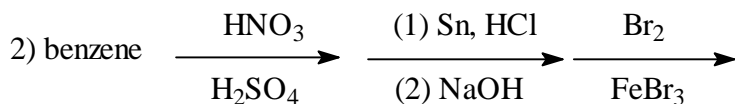
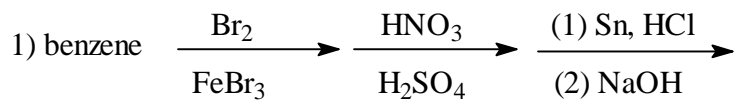
26. Heating butylmalonic acid,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}(\text{CO}_2\text{H})_2$ , to  $140^\circ\text{C}$  yields:

- A) hexanoic acid
- B) pentanoic acid
- C) 2-methylpentanoic acid
- D) 2-hexenoic acid

27. Reaction of an *N,N*-dialkylaniline with nitrous acid yields:

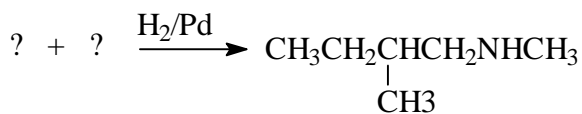
- A) a diazonium salt.
- B) a *para*-nitroso compound.
- C) an *N*-nitroso compound.
- D) an azo compound.

28. Which one of the following synthetic routes gives the best yield of *meta*-bromoaniline starting with benzene?



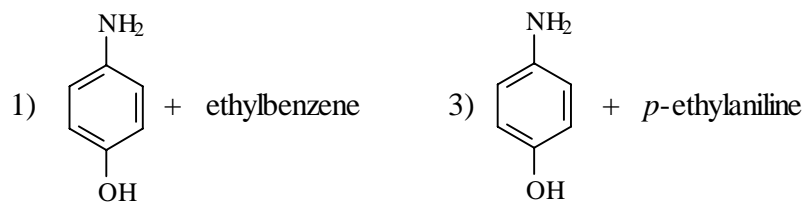
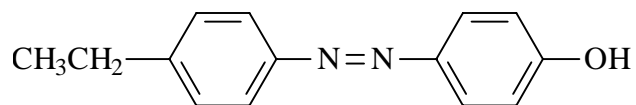
- A) is 1
- B) is 2
- C) is 3
- D) is 4

29. Which pair of reagents would be used to make the following amine by reductive amination?



- A) methylamine and 2-methylbutanoic acid
- B) methylamine and 2-methylbutanal
- C) ammonia and 3-methyl-2-pentanone
- D) dimethylamine and 2-butanone

30. Which of the following would be the starting reagents needed to make the azo compound shown below?



2) *p*-ethylaniline and phenol

4) aniline and *p*-ethylphenol

- A) is 1
- B) is 2
- C) is 3
- D) is 4

## Answer Key

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