

Exam

Name _____

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 1) Provide the major resonance structures of the intermediate sigma complex in the reaction of benzene with the generic electrophile E^+ . 1) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 2) In the bromination of benzene using Br_2 and $FeBr_3$, is the intermediate carbocation aromatic? Explain.
- 3) Which step in an electrophilic aromatic substitution reaction is typically rate determining, formation of the sigma complex or loss of H^+ by the sigma complex to form the product? Explain.
- 4) Provide a detailed, stepwise mechanism for the reaction of benzene with Br_2 and $FeBr_3$. Make sure to include the activating reaction between Br_2 and $FeBr_3$ in your mechanism.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 5) Under what reaction conditions does the electrophilic chlorination of aromatic compounds usually occur? 5) _____
A) $NaCl, CH_3OH$
B) $Cl_2, AlCl_3$
C) Cl_2, CCl_4
D) $NaCl, H_2O$
E) Cl_2, H_2O
- 6) Which of the following species is attacked by benzene in the electrophilic nitration reaction? 6) _____
A) HNO_3 B) NO_2^+ C) NO_2 D) N_3^- E) NO^+

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 7) Name the major organic product which results when 3-ethylbenzenesulfonic acid is heated in aqueous acid. 7) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 8) In electrophilic aromatic substitution reactions the hydroxyl group is an o,p-director because: 8) _____
A) it donates electron density to the ring by resonance and stabilizes the ortho and para sigma complexes.
B) it donates electron density to the ring by induction and stabilizes the ortho and para sigma complexes.
C) it donates electron density to the ring by resonance and destabilizes the meta sigma complex.
D) it withdraws electron density from the ring by induction and destabilizes the meta sigma complex.
E) it donates electron density to the ring by induction and destabilizes the meta sigma complex.

- 9) In electrophilic aromatic substitution reactions the nitro group is: 9) _____
- A) an o,p-director since it stabilizes the ortho, para sigma complex less than the meta.
 - B) a m-director since it destabilizes the meta sigma complex less than the ortho, para.
 - C) an o,p-director since it stabilizes the ortho, para sigma complex more than the meta.
 - D) a m-director since it destabilizes the meta sigma complex more than the ortho, para.
 - E) none of the above.

- 10) The nitration of anisole: 10) _____
- A) proceeds at the same rate as the nitration of benzene and yields predominantly the meta product.
 - B) proceeds more rapidly than the nitration of benzene and yields predominantly the ortho, para products.
 - C) proceeds more slowly than the nitration of benzene and yields predominantly the ortho, para products.
 - D) proceeds more slowly than the nitration of benzene and yields predominantly the meta product.
 - E) proceeds more rapidly than the nitration of benzene and yields predominantly the meta product.

- 11) Which of the following is the strongest activating group in electrophilic aromatic substitution reactions? 11) _____
- A) $-\text{OCH}_3$ B) $-\text{N}(\text{CH}_3)_2$ C) $-\text{CH}_2\text{CH}_3$ D) $-\text{NO}_2$ E) $-\text{CO}_2\text{CH}_3$

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 12) Rank the following groups in order of increasing activating power in electrophilic aromatic substitution reactions: $-\text{OCH}_3$, $-\text{OCOCH}_2\text{CH}_3$, $-\text{CH}_2\text{CH}_3$, $-\text{Br}$.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 13) In electrophilic aromatic substitution reactions a bromine substituent: 13) _____
- A) is a deactivator and an o,p-director.
 - B) is an activator and a m-director.
 - C) is a deactivator and a m-director.
 - D) is an activator and an o,p-director.
 - E) none of the above

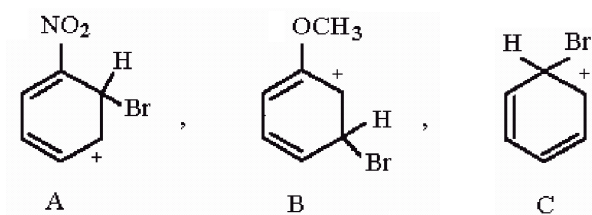
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 14) Draw the four major resonance structures of the sigma complex intermediate in the reaction of anisole with $\text{HNO}_3/\text{H}_2\text{SO}_4$ to yield *p*-nitroanisole. 14) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 15) Draw the three major resonance structures of the sigma complex intermediate in the reaction of acetophenone with $\text{HNO}_3/\text{H}_2\text{SO}_4$ to yield *o*-nitroacetophenone. Circle the resonance form which is less stable than the other two.

16) Rank the following sigma complexes in order of increasing stability.



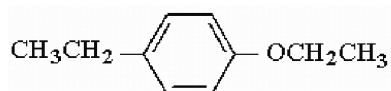
17) Provide a series of synthetic steps by which 2-bromo-4-nitrobenzoic acid can be prepared from toluene.

18) Provide a series of synthetic steps by which 3-bromoethylbenzene can be prepared from benzene.

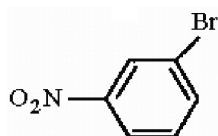
19) Provide a series of synthetic steps by which 4-*t*-butylbenzoic acid can be prepared from toluene.

20) Provide a series of synthetic steps by which *p*-nitrobutylbenzene can be prepared from benzene.

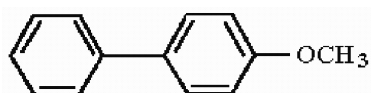
21) Provide the structure of the major mononitration product of the compound below.



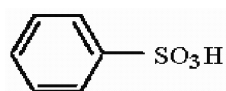
22) Provide the structure of the major mononitration product(s) of the compound below.



23) Provide the structure of the major mononitration product of the compound below.



24) Provide the structure of the major mononitration product of the compound below.



MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

25) Which of the following compounds will undergo bromination most rapidly using Br₂, FeBr₃? 25) _____

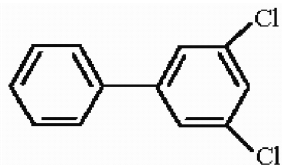
- A) benzenesulfonic acid
- B) *p*-methylacetanilide
- C) dibromobenzene
- D) bromobenzene
- E) acetanilide

26) In the addition of an electrophile to acetophenone, which of the following best describes the expected mode of reaction? 26) _____

- A) The m-positions are most activated to attack by the electrophile.
- B) The o,p-positions are most deactivated to attack by the electrophile.
- C) The o,p-positions are most activated to attack by the electrophile.
- D) The m-positions are most deactivated to attack by the electrophile.
- E) All positions (o, m, and p) are equally activated to attack by the electrophile.

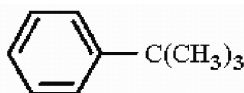
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

27) Provide the structure of the major mononitration product(s) of the compound below. 27) _____

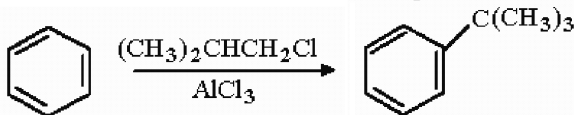


ESSAY. Write your answer in the space provided or on a separate sheet of paper.

28) Provide the structure of the major mononitration product of the compound below.

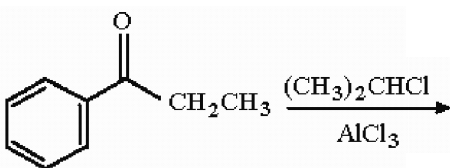


29) Provide a detailed, stepwise mechanism for the following reactions.

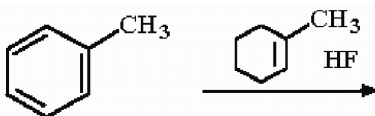


30) List two of the three limitations usually associated with the Friedel-Crafts alkylation reaction.

31) Provide the structure of the major organic product of the following reaction.



32) Provide the structure of the major organic product of the following reaction.

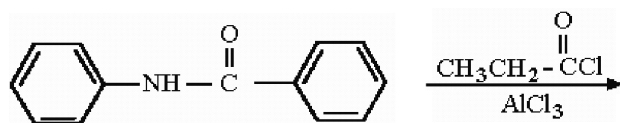


MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 33) Which of the following compounds would most likely be used in the preparation of isobutylbenzene from benzene? 33) _____
- A) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COCl}$
 - B) $(\text{CH}_3)_2\text{CHCH}_2\text{Cl}$
 - C) $(\text{CH}_3)_2\text{CHCOCl}$
 - D) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$
 - E) $(\text{CH}_3)_2\text{CHCH}_2\text{Br}$

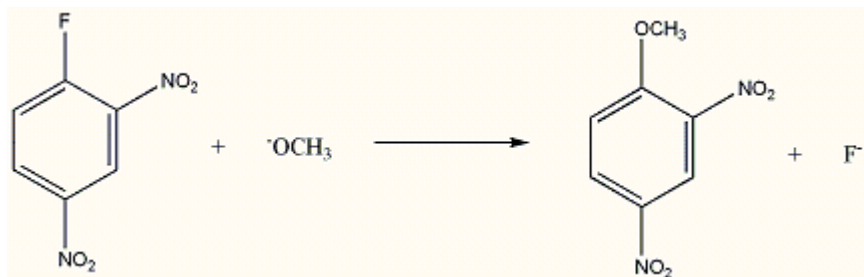
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 34) Provide the structure of the major organic product of the following reaction. 34) _____

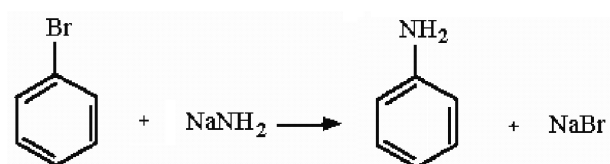


ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 35) Draw the two major resonance structures of the acylium ion which results when butanoyl chloride [$\text{CH}_3\text{CH}_2\text{CH}_2\text{COCl}$] is treated with AlCl_3 .
- 36) Why are Friedel-Crafts acylation reactions not prone to polyacylation?
- 37) Provide a detailed, stepwise mechanism for the following reaction.



- 38) Provide a detailed, stepwise mechanism for the following reaction.



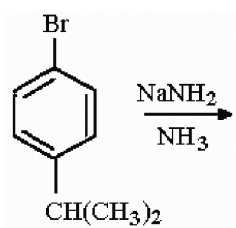
- 39) Provide a series of synthetic steps by which *p*-nitrophenol can be prepared from benzene.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 40) When *o*-fluorotoluene is treated with sodium amide, the product is: 40) _____
A) a mixture of *o*- and *m*-toluidine.
B) only *m*-toluidine.
C) only *o*-toluidine.
D) only *p*-toluidine.
E) a mixture of *o*- and *p*-toluidine.
- 41) Which of the following compounds is least reactive in the nucleophilic aromatic substitution reaction with NaOH? 41) _____
A) *p*-nitrochlorobenzene
B) *m*-nitrochlorobenzene
C) 2,4-dinitrochlorobenzene
D) *o*-nitrochlorobenzene
E) 3,5-dinitrochlorobenzene

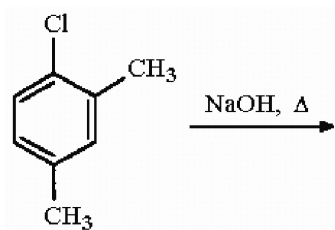
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 42) Provide the structures of the major organic products of the following reaction. 42) _____



ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 43) Provide the structures of the major organic products of the following reaction.



- 44) Draw the four major resonance structures of the intermediate which results when *o*-nitrochlorobenzene is treated with NaOH.

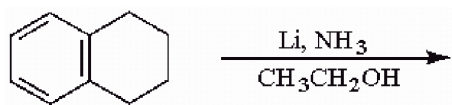
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 45) Which toluidine isomers are possible products when *m*-bromotoluene is treated with NaNH₂? 45) _____
A) ortho only
B) meta only
C) ortho, meta, and para
D) meta and para only
E) para only

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

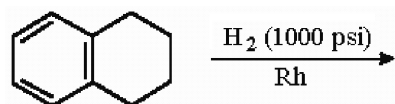
46) Provide the structure of the major organic product in the following reaction.

46) _____

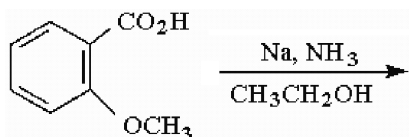


ESSAY. Write your answer in the space provided or on a separate sheet of paper.

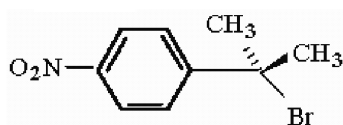
47) Provide the structures of the major organic products in the following reaction.



48) Provide the structure of the major organic product in the following reaction

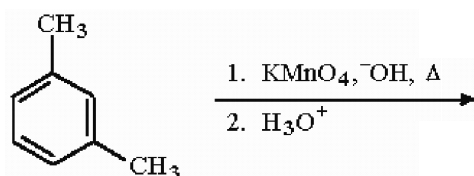


49) Provide a series of synthetic steps by which the compound below can be prepared from benzene.

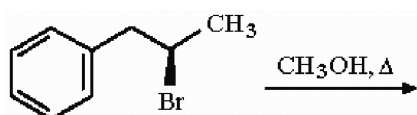


50) Provide a series of synthetic steps by which 4-phenylheptan-4-ol can be prepared from benzene.

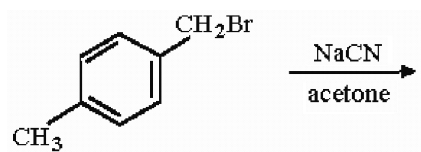
51) Provide the structure of the major organic product in the following reaction.



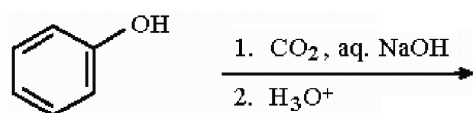
52) Provide the structure of the major organic product in the following reaction.



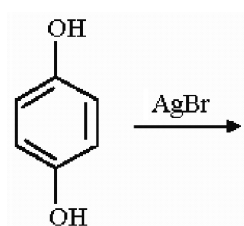
53) Provide the structure of the major organic product in the following reaction.



54) Provide the structure of the major organic product in the following reaction.

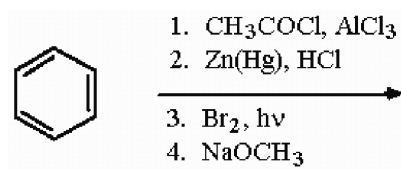


55) Provide the structure of the major organic product in the following reaction.

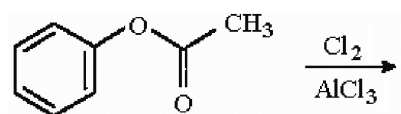


56) Provide a series of synthetic steps by which *p*-methylanisole can be prepared from *p*-cresol.

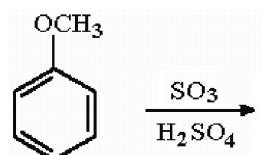
57) Provide the structure of the major organic product in the following reaction sequence.



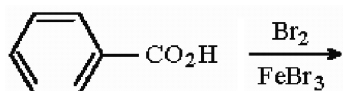
58) Provide the structure of the major organic product(s) in the following reaction.



59) Provide the structure of the major organic product(s) in the following reaction.



60) Provide the structure of the major organic product(s) in the following reaction.



MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

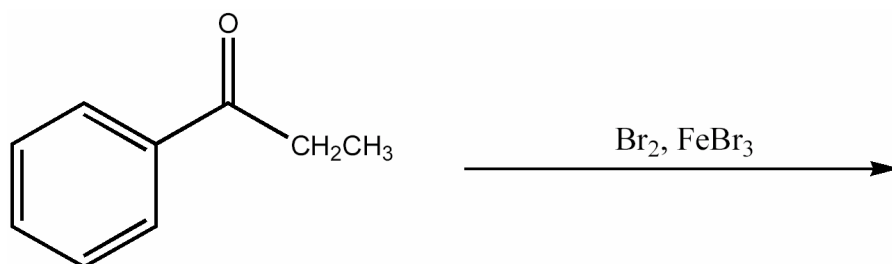
- 61) Which of the following is the best choice of reagents to effect the electrophilic iodination of an aromatic ring? 61) _____
A) KI, acetone
B) I_2 , CH_3CN
C) I_2 , HNO_3
D) KI, HNO_3
E) none of the above
- 62) In electrophilic aromatic substitution reactions, a $-\text{CO}_2\text{H}$ substituent on the aromatic ring is: 62) _____
A) an activator and a m-director.
B) a deactivator and a m-director.
C) a deactivator and an o,p-director.
D) an activator and an o,p-director.
E) none of the above.
- 63) In electrophilic aromatic substitution reactions, a $-\text{NHCOCH}_3$ substituent on the aromatic ring is: 63) _____
A) an activator and an o,p-director.
B) a deactivator and an o,p-director.
C) a deactivator and a m-director.
D) an activator and a m-director.
E) none of the above.
- 64) In electrophilic aromatic substitution reactions, a phenyl substituent on the aromatic ring is: 64) _____
A) a deactivator and an o,p-director.
B) an activator and an o,p-director.
C) an activator and a m-director.
D) a deactivator and a m-director.
E) none of the above.
- 65) In electrophilic aromatic substitution reactions, a cyano substituent on the aromatic ring is: 65) _____
A) an activator and a m-director.
B) a deactivator and an o,p-director.
C) a deactivator and a m-director.
D) an activator and an o,p-director.
E) none of the above.

- 66) Which of the following compounds will undergo Friedel-Crafts alkylation with $(\text{CH}_3)_3\text{CCl}$, AlCl_3 most rapidly? 66) _____
- A) benzenesulfonic acid
 - B) toluene
 - C) acetophenone
 - D) cyanobenzene
 - E) iodobenzene
- 67) Which of the following compounds will not undergo Friedel-Crafts acylation when treated with $\text{CH}_3\text{CH}_2\text{COCl}$, AlCl_3 ? 67) _____
- A) toluene
 - B) anisole
 - C) benzophenone
 - D) ethoxybenzene
 - E) *p*-xylene
- 68) *p*-Methoxybenzaldehyde can be prepared from anisole using the Gatterman-Koch formylation. What mixture of reagents is necessary for this process? 68) _____
- A) CO_2 , HCl , AlCl_3
 - B) CO , HCl , AlCl_3 , CuCl
 - C) CO_2 , HNO_3 , H_2SO_4
 - D) CO , SO_3 , H_2SO_4
 - E) CO_2 , SO_3 , H_2SO_4
- 69) When 2,4-dinitrochlorobenzene is treated with sodium hydroxide at 100°C followed by protonation: 69) _____
- A) 2,4-dinitrophenol is formed via an addition-elimination nucleophilic aromatic substitution mechanism.
 - B) 3,5-dinitrophenol is formed via an electrophilic aromatic substitution mechanism.
 - C) 2,4-dinitrophenol is formed via an electrophilic aromatic substitution mechanism.
 - D) 2,4-dinitrophenol is formed via an elimination-addition nucleophilic aromatic substitution mechanism.
 - E) 3,5-dinitrophenol is formed via an elimination-addition nucleophilic aromatic substitution mechanism.
- 70) What intermediate is thought to occur in the elimination-addition nucleophilic aromatic substitution mechanism? 70) _____
- A) quinone
 - B) radical cation
 - C) radical anion
 - D) benzyne
 - E) positively charged sigma complex

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

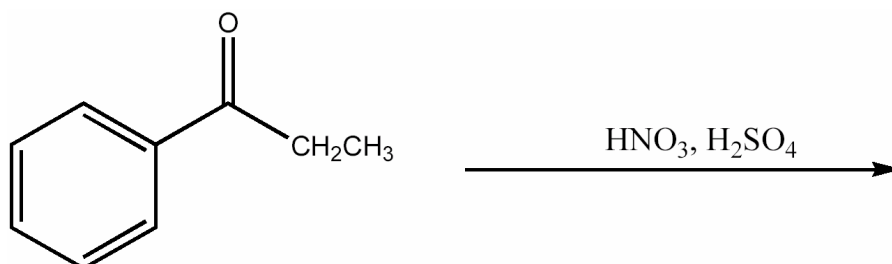
71) Provide the major organic product of the following reaction.

71) _____



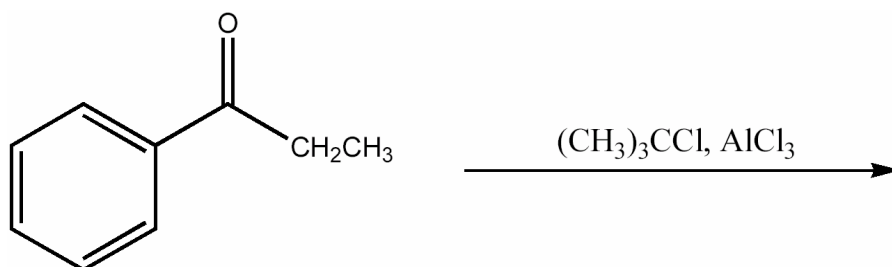
72) Provide the major organic product of the following reaction.

72) _____



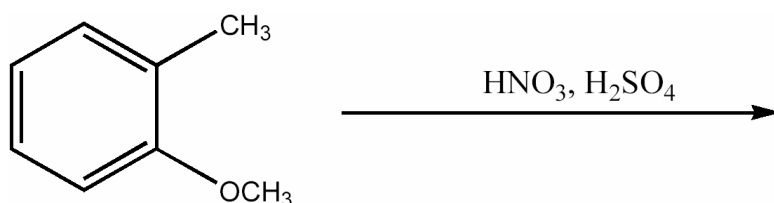
73) Provide the major organic product of the following reaction.

73) _____



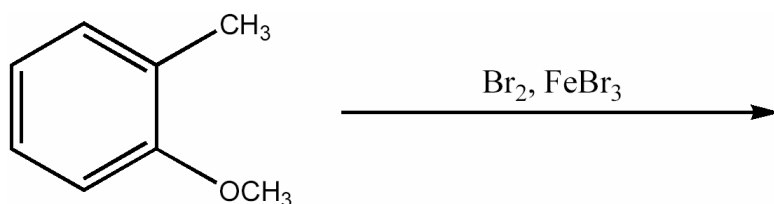
74) Provide the major organic product of the following reaction.

74) _____



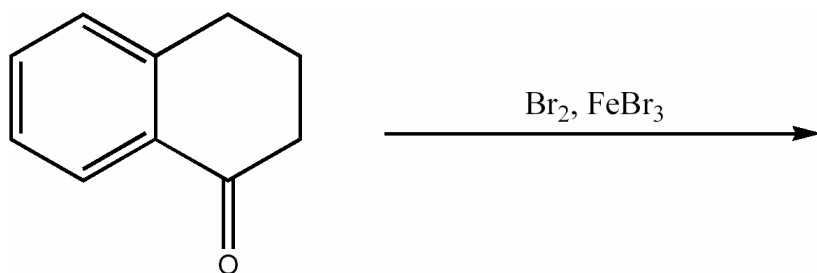
75) Provide the major organic product of the following reaction.

75) _____



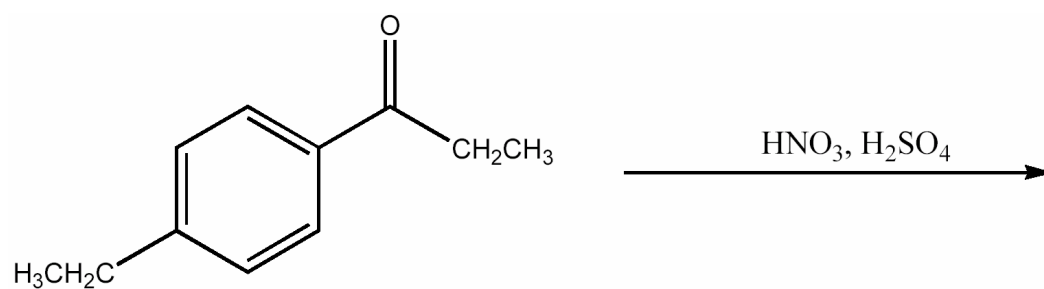
76) Provide the major organic product of the following reaction.

76) _____



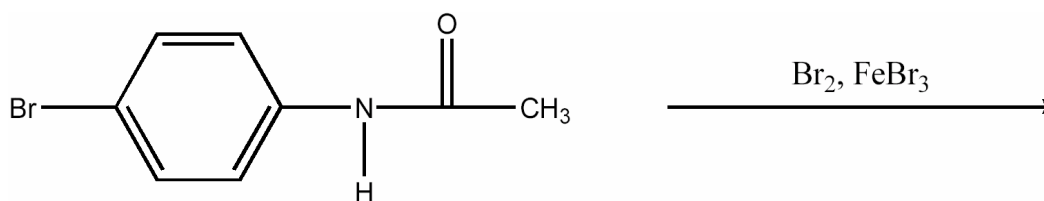
77) Provide the major organic product of the following reaction.

77) _____



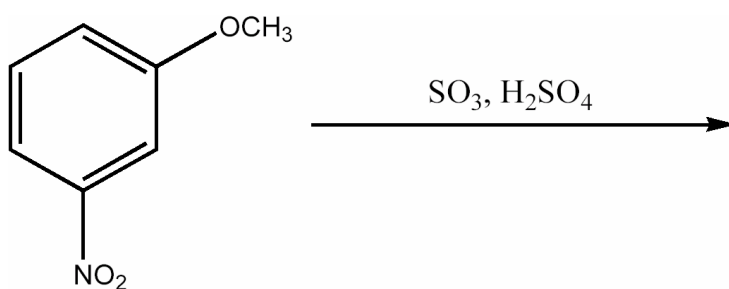
78) Provide the major organic product of the following reaction.

78) _____



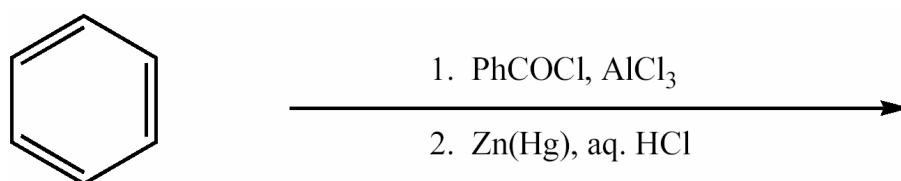
79) Provide the major organic product of the following reaction.

79) _____



80) Provide the major organic product of the following reaction sequence.

80) _____



MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 81) Which of the following is an incorrect statement about the bromination of benzene by Br_2 and FeBr_3 ? 81) _____
- A) Formation of the sigma complex is the rate-determining step of the mechanism.
 - B) There are two carbon-containing intermediates in the mechanism.
 - C) The final step of the mechanism is loss of H^+ .
 - D) The carbanionic intermediate is resonance stabilized.
 - E) FeBr_3 functions to increase the electrophilicity of Br_2 .

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 82) Electrophilic iodination of benzene requires which reagent in addition to I_2 ? 82) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 83) Which of the following compounds will undergo bromination least rapidly when treated with Br_2 and FeBr_3 ? 83) _____
- A) p-methylacetanilide
 - B) bromobenzene
 - C) benzene
 - D) acetanilide
 - E) benzenesulfonic acid

- 84) Which of the following compounds will react most rapidly when treated with $\text{CH}_3\text{CH}_2\text{Cl}$ and AlCl_3 ? 84) _____
- A) benzene
 - B) nitrobenzene
 - C) anisole
 - D) chlorobenzene
 - E) toluene

- 85) Which of the following compounds will react least rapidly when treated with $\text{CH}_3\text{CH}_2\text{Cl}$ and AlCl_3 ? 85) _____
- A) o-xylene
 - B) benzene
 - C) toluene
 - D) acetanilide
 - E) bromobenzene

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 86) Provide the major organic product that results when benzene is treated with the following sequence of reagents: 1. HNO_3 , H_2SO_4 2. Br_2 , FeBr_3 . 86) _____
- 87) Provide the major organic product that results when benzene is treated with the following sequence of reagents: 1. Br_2 , FeBr_3 2. HNO_3 , H_2SO_4 . 87) _____

88) Provide the major organic product that results when benzene is treated with the following sequence of reagents: 1. Br_2 , FeBr_3 2. CH_3COCl , AlCl_3 . 88) _____

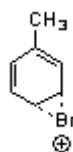
89) Provide the major organic product that results when benzene is treated with the following sequence of reagents: 1. CH_3COCl , AlCl_3 2. Br_2 , FeBr_3 . 89) _____

90) What sequence of reagents is needed to convert benzene into m-bromoethylbenzene? 90) _____

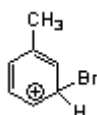
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

91) Which of the following is an intermediate in the bromination of toluene? 91) _____

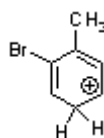
A)



B)



C)

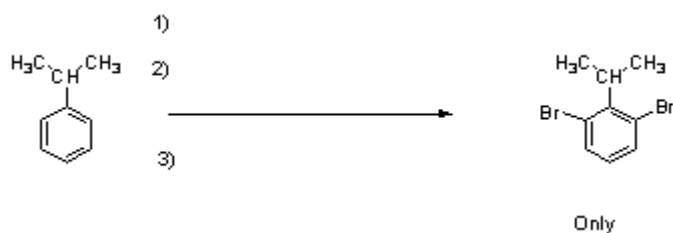


D)



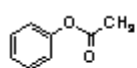
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

92) Provide the necessary reagents to accomplish the following transformation. 92) _____

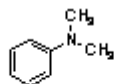


MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

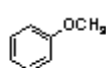
93) Which sequence correctly ranks the following aromatic rings in order of increasing rate of reactivity with chlorine and aluminum chloride 93) _____



1



2



3

A) $3 < 2 < 1$

B) $2 < 3 < 1$

C) $2 < 1 < 3$

D) $1 < 3 < 2$

E) $1 < 2 < 3$

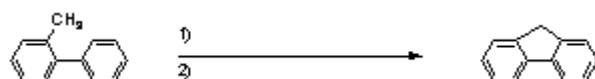
SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

94) Show how the following product can be made from benzene. 94) _____



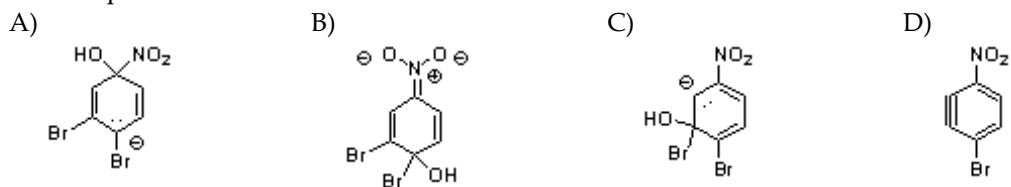
95) Show what reagents are needed to complete the transformation below.

95) _____



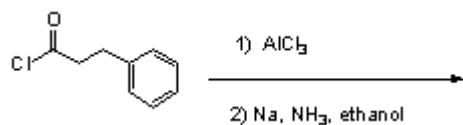
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

96) Which of the following is an intermediate when 1,2-dibromo-4-nitrobenzene is heated with NaOH 96) _____
in a nucleophilic aromatic substitution reaction?

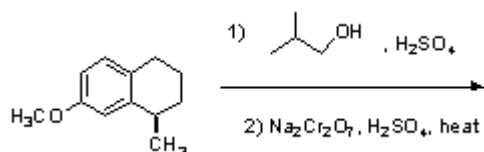


SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

97) Predict the major organic product resulting from the following sequence of reactions. 97) _____



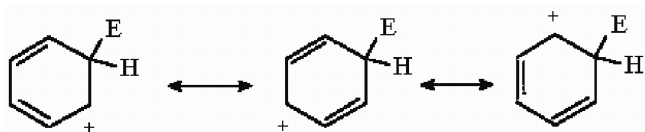
98) Draw the major organic structure that results from the following sequence of reactions. 98) _____



Answer Key

Testname: AROMA_2_ALL

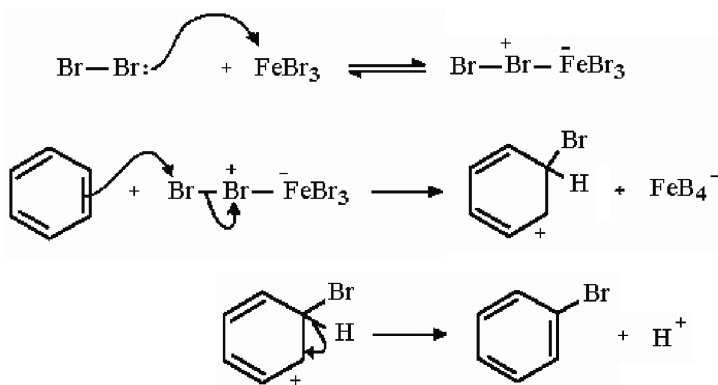
1)



2) No, the carbocation is not aromatic since the ring contains an sp^3 center.

3) Formation of the sigma complex is typically rate determining. This endothermic step goes through a high energy transition state on the path from an aromatic starting material to a nonaromatic, carbocationic intermediate.

4)



5) B

6) B

7) ethylbenzene

8) A

9) B

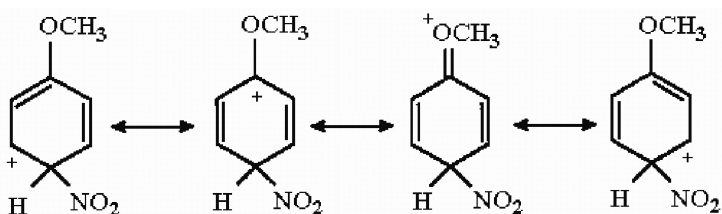
10) B

11) B

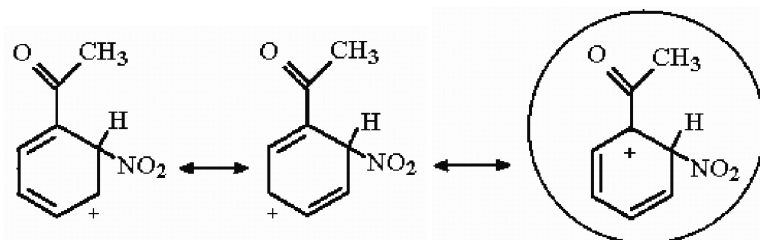
12) $-Br < -CH_2CH_3 < -OCOCH_2CH_3 < -OCH_3$

13) A

14)



15)



16) $A < B < C$

Answer Key

Testname: AROMA_2_ALL

17) 1. HNO₃, H₂SO₄

2. Br₂, FeBr₃

3. KMnO₄, OH⁻, Δ

4. H⁺

18) 1. CH₃COCl, AlCl₃

2. Br₂, FeBr₃

3. Zn(Hg), HCl

19) 1. (CH₃)₃CCl, AlCl₃

2. KMnO₄, OH⁻, Δ

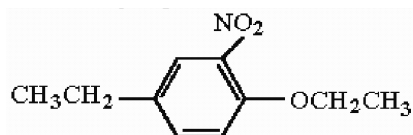
3. H⁺

20) 1. CH₃CH₂CH₂COCl, AlCl₃

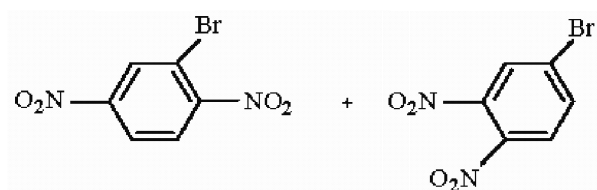
2. Zn(Hg), HCl

3. HNO₃, H₂SO₄

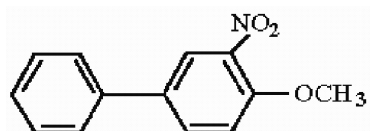
21)



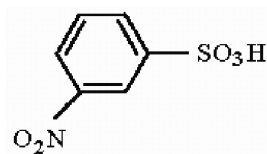
22)



23)



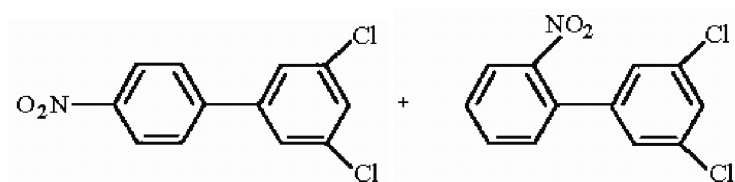
24)



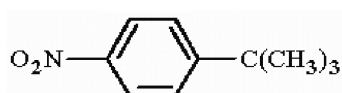
25) B

26) B

27)



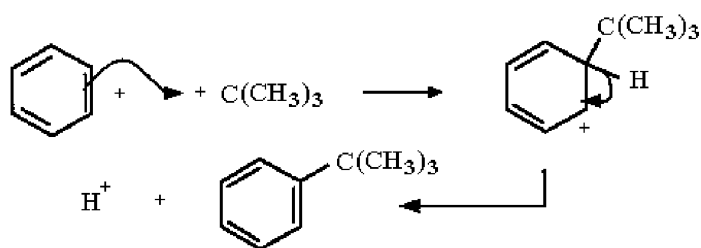
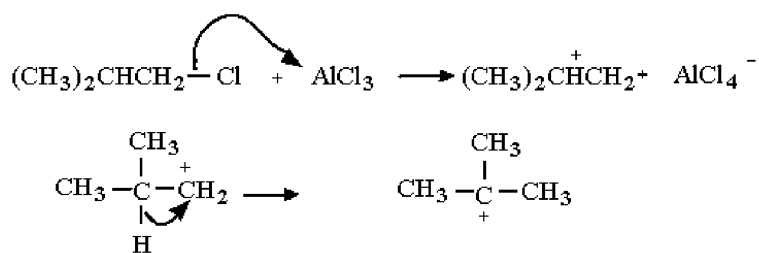
28)



Answer Key

Testname: AROMA_2_ALL

29)



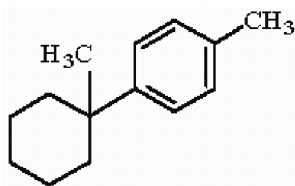
30) 1. Reaction fails when strongly deactivating substituents are present.

2. Rearrangements are possible; *n*-alkyl derivatives are unavailable.

3. Multiple alkylations frequently occur.

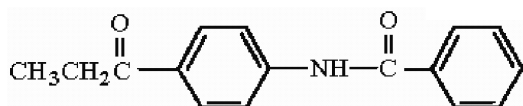
31) No reaction. The ring is too deactivated by the acyl substituent to undergo Friedel-Crafts alkylation.

32)

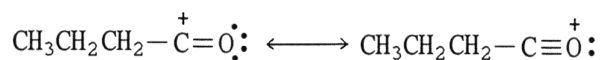


33) C

34)



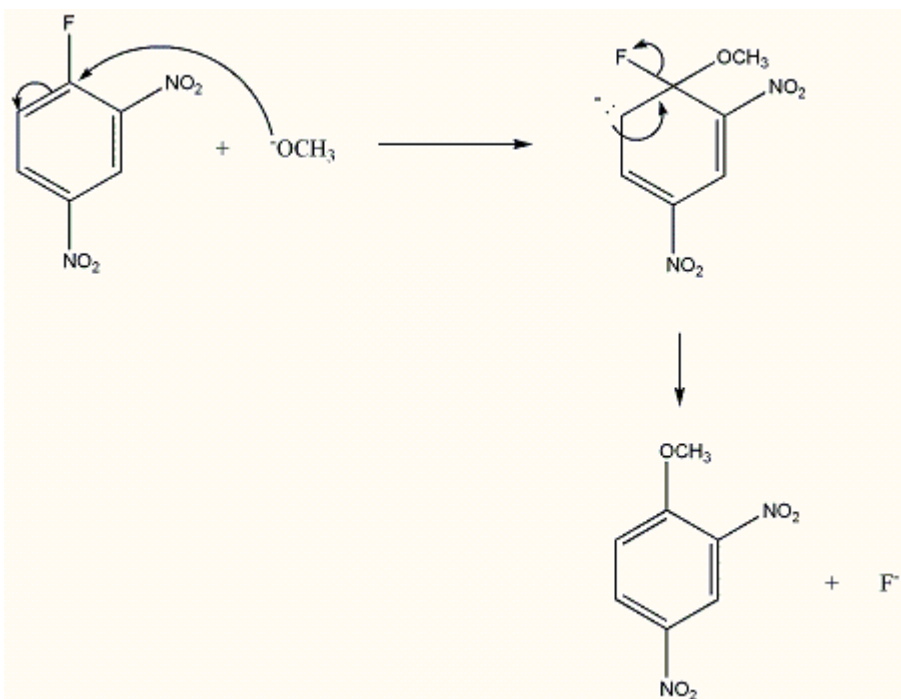
35)



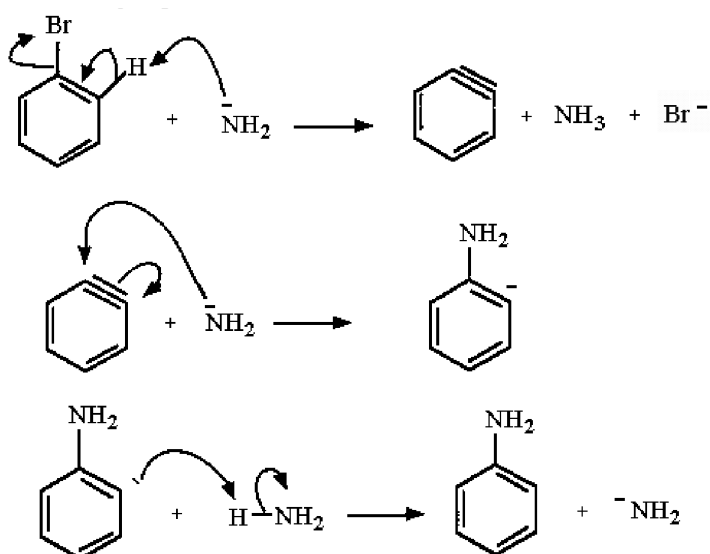
36) Once the ring is acylated, it is deactivated to further electrophilic attack since the acyl group is electron withdrawing.

Answer Key
 Testname: AROMA_2_ALL

37)



38)



- 39) 1. Cl_2 , AlCl_3
 2. HNO_3 , H_2SO_4
 3. NaOH , H_2O , Δ
 4. H^+

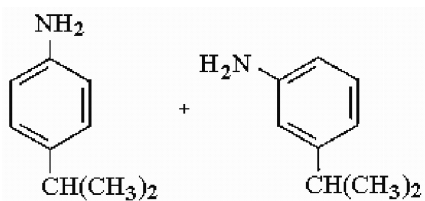
40) A

41) B

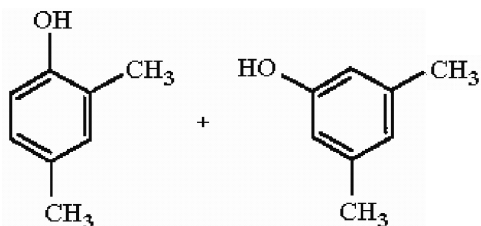
Answer Key

Testname: AROMA_2_ALL

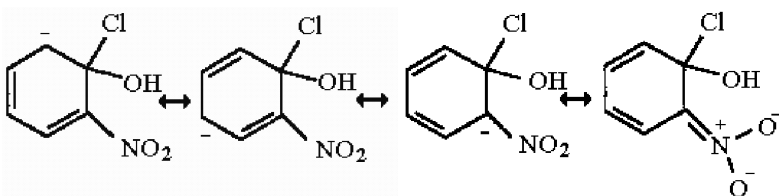
42)



43)

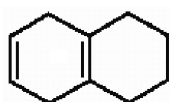


44)

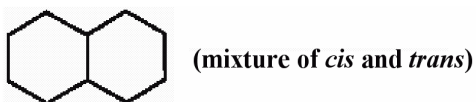


45) C

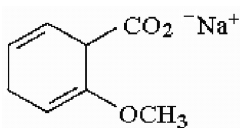
46)



47)



48)



49) 1. $(\text{CH}_3)_2\text{CHCl}$, AlCl_3

2. HNO_3 , H_2SO_4

3. Br_2 , $h\nu$

50) 1. Br_2 , FeBr_3

2. Mg , ether

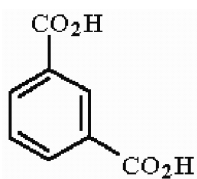
3. $\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_2\text{CH}_2\text{CH}_3$

4. H_3O^+

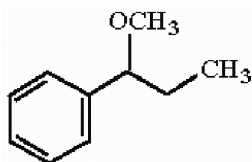
Answer Key

Testname: AROMA_2_ALL

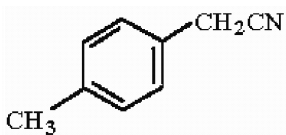
51)



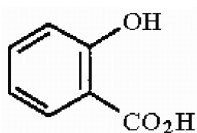
52)



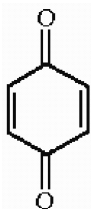
53)



54)



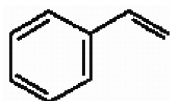
55)



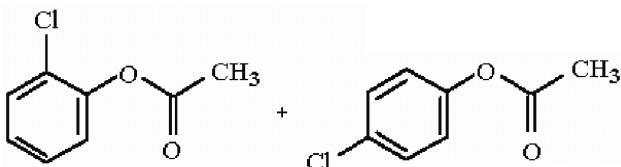
56) 1. NaOH

2. $(\text{CH}_3\text{O})_2\text{SO}_2$ or CH_3I

57)



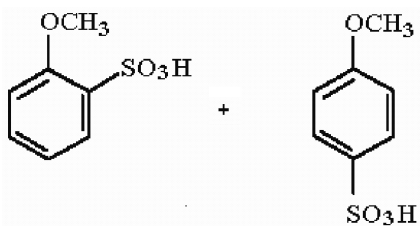
58)



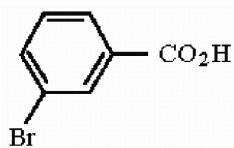
Answer Key

Testname: AROMA_2_ALL

59)



60)



61) C

62) B

63) A

64) B

65) C

66) B

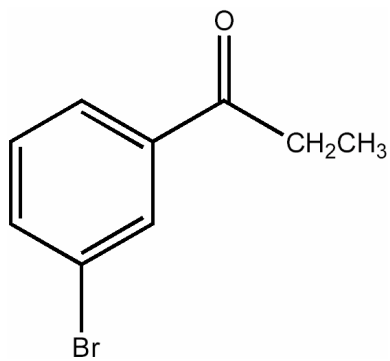
67) C

68) B

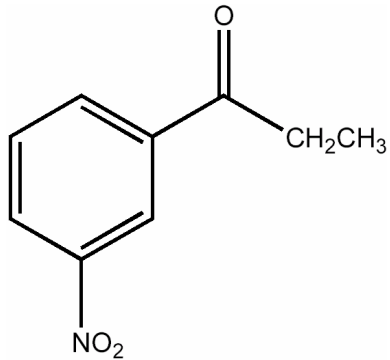
69) A

70) D

71)



72)

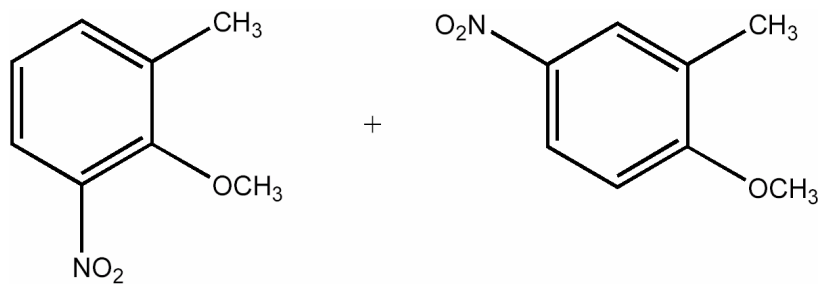


73) No reaction. Friedel-Crafts alkylation reactions will not proceed when the aromatic ring of the starting material is deactivated.

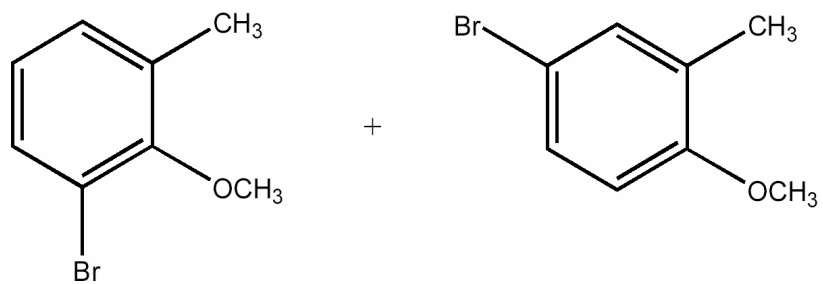
Answer Key

Testname: AROMA_2_ALL

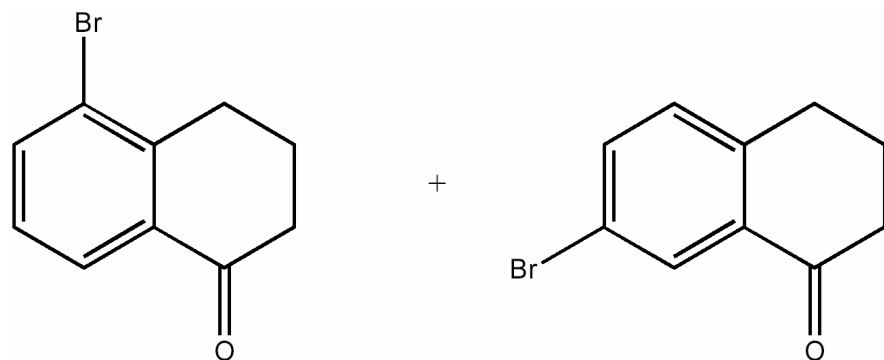
74)



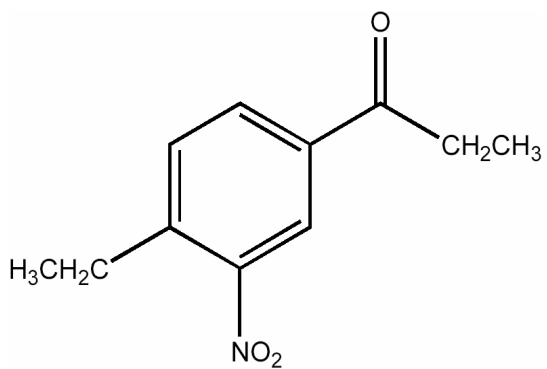
75)



76)



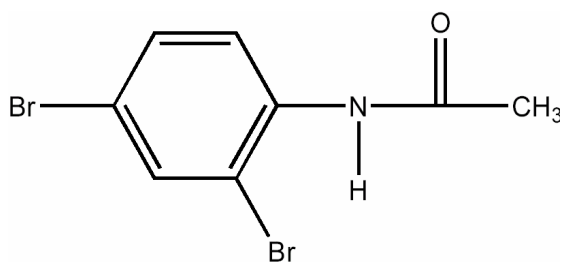
77)



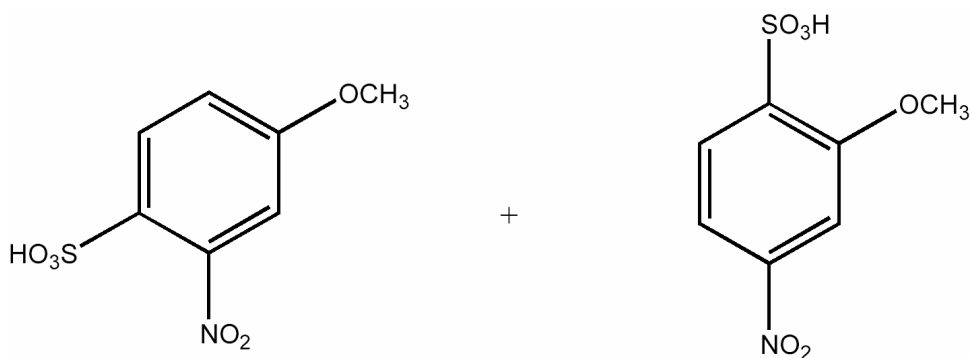
Answer Key

Testname: AROMA_2_ALL

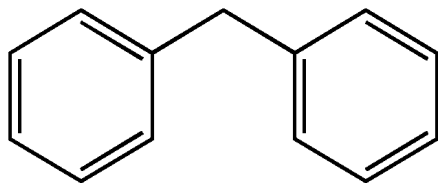
78)



79)



80)



81) D

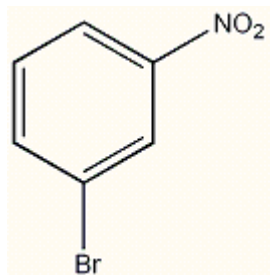
82) HNO₃

83) E

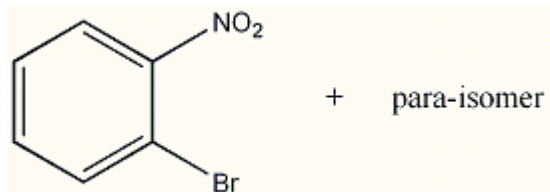
84) C

85) E

86)



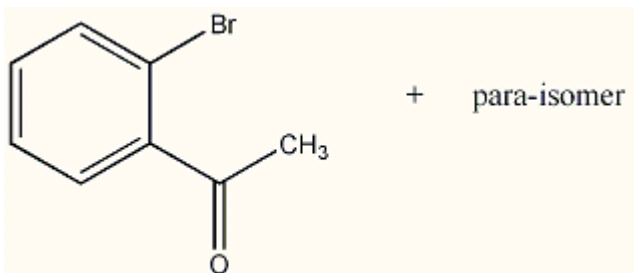
87)



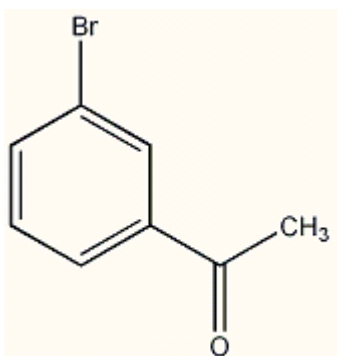
Answer Key

Testname: AROMA_2_ALL

88)



89)



90) 1. CH₃COCl, AlCl₃

2. Br₂, FeBr₃

3. Zn(Hg), HCl

91) D

92) 1) SO₃ / H₂SO₄ 2) excess Br₂ / FeBr₃ 3) H⁺, H₂O, heat

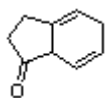
93) D

94) 1) isobutyryl chloride / AlCl₃ 2) I₂ / HNO₃ 3) Zn (Hg)/ aq HCl

95) 1) Cl₂ / hv 2) AlCl₃

96) B

97)



98)

