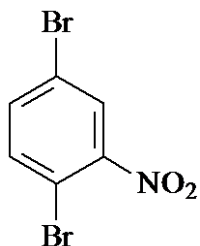
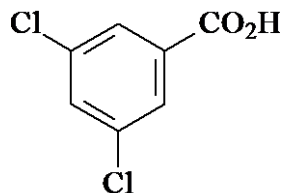


ACS Review Arenes and Aromaticity

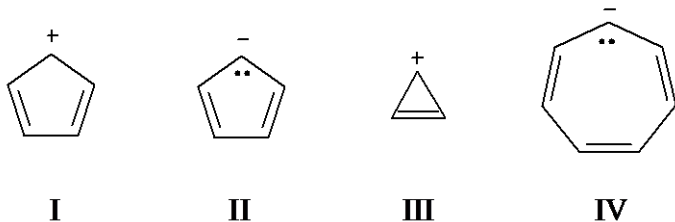
1. What is the correct IUPAC name of the following compound?



- A. 1,4-dibromo-3-nitrobenzene
B. 1,4-dibromo-2-nitrobenzene
C. 2-nitro-1,4-dibromobenzene
D. 1-nitro-2,5-dibromobenzene
2. How many isomeric tribromobenzenes are possible?
- A. one
B. two
C. three
D. four
3. Which of the following is not true concerning the structure of benzene?
- A. All C-C-C bond angles are exactly 120°.
B. The carbon-carbon bonds rapidly alternate between single and double bonds.
C. The six hydrogens are equivalent.
D. The π bonds are completely conjugated.
4. What is the IUPAC name of the following compound?

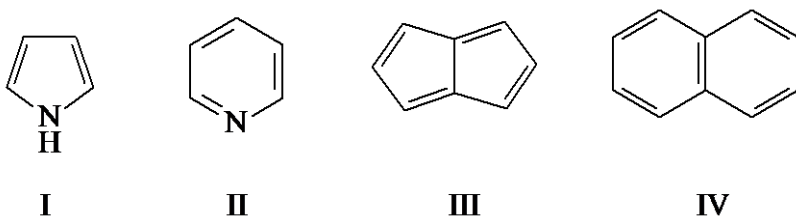


- A. 4,6-dichloro-2-benzoic acid
B. 2,4-dichlorobenzoic acid
C. 3,5-dichlorobenzoic acid
D. *meta*-dichlorobenzoic acid
5. The total number of resonance forms of the cyclopentadienide anion, C₅H₅⁻, is:
- A. two
B. three
C. four
D. five
6. Which of the following ions are aromatic species?



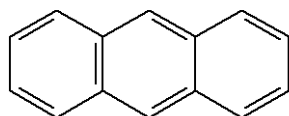
- A. I and III
 B. II and III
 C. II and IV
 D. III and IV

7. Identify the aromatic compounds.



- A. I and II
 B. III and IV
 C. I, II, and IV
 D. all of them

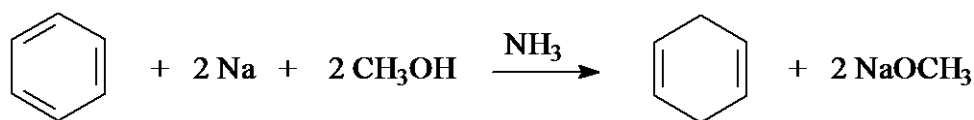
8. How many isomeric bromoanthracenes are there?



anthracene

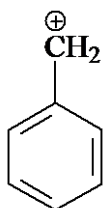
- A. none, only one structure
 B. two
 C. three
 D. four
9. Which of the following reacts at the fastest rate when heated with N-bromosuccinimide (NBS) and benzoyl peroxide in carbon tetrachloride at 80°C?
- A. toluene
 B. ethylbenzene
 C. isopropylbenzene (cumene)
 D. *tert*-butylbenzene
10. The Birch reduction of benzene with sodium in NH₃/CH₃OH goes by a four-step mechanism. The first step is the:
- A. transfer of a proton from CH₃OH to benzene.
 B. transfer of an electron from Na to benzene.
 C. transfer of an electron from benzene to NH₃.
 D. transfer of a hydride ion, H⁻, from NH₃ to benzene.

11. Which species is oxidized in the Birch reduction shown below?



- A. benzene
- B. Na
- C. CH₃OH
- D. NH₃

12. The benzyl carbocation is shown below. Besides the benzylic carbon, identify any other carbon atoms which carry a partial positive charge based on resonance theory.



- A. ortho and para carbon atoms
- B. meta carbon atoms
- C. meta and para carbon atoms
- D. ortho and meta carbon atoms

13. Side chain oxidations of alkylbenzenes with Na₂Cr₂O₇ and H₂SO₄/H₂O will not work if the alkyl side chain has:

- A. only one carbon.
- B. four or more carbons.
- C. benzylic hydrogens.
- D. no benzylic hydrogens.

14. Which of the following are consistent with the requirements for aromaticity?

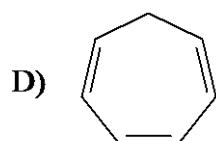
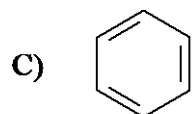
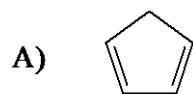
- I. A system with delocalized π electrons in a ring.
- II. $4n$ π electrons in the ring.
- III. All the ring atoms must be carbons.
- IV. $(4n + 2)$ π electrons in the ring.

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

15. Cyclopentadiene is unusually acidic for a hydrocarbon. Why?

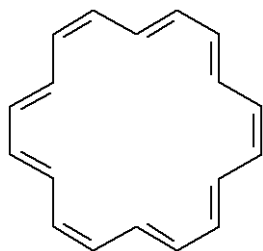
- A. Cyclopentadiene is aromatic.
- B. The conjugate base of cyclopentadiene is aromatic.
- C. Cyclopentadiene is an unstable diradical.
- D. The conjugate base of cyclopentadiene is an unstable diradical.

16. Which of the following would most readily react with a strong base, such as NaNH₂, to form a carbanion?



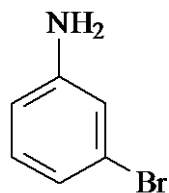
- A. A
- B. B
- C. C
- D. D

17. What is the value of n from Huckel's rule for the following aromatic compound?



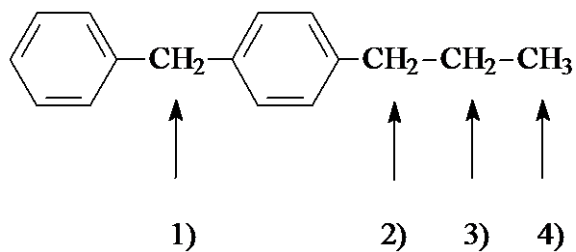
- A. $n = 3$
- B. $n = 4$
- C. $n = 5$
- D. $n = 9$

18. The name of the following compound is:



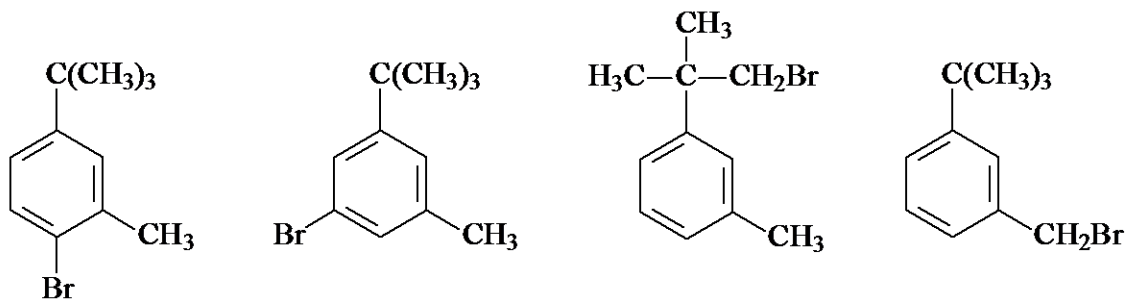
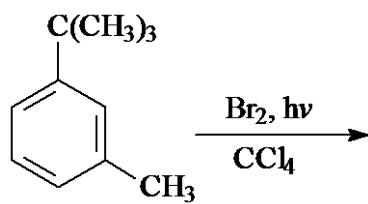
- A. *meta*-bromoaniline
- B. *meta*-bromonitrobenzene
- C. *meta*-bromoaniline
- D. *meta*-bromophenol

19. Which hydrogen atom would be most easily extracted by a bromine atom?



- A. 1
 B. 2
 C. 3
 D. 4

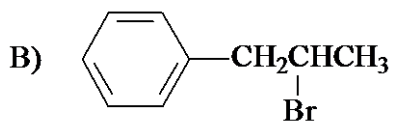
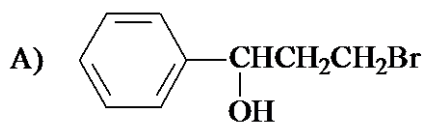
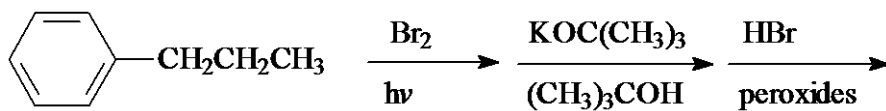
20. What is the product of the reaction shown below?

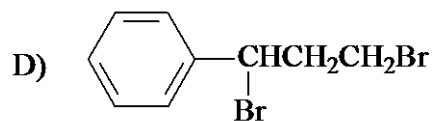
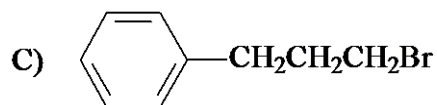


- I. II. III. IV.

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

21. Propylbenzene is subjected to the sequence of reactions below. What is the final product?





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

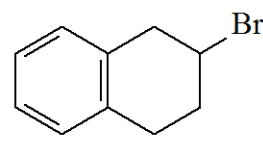
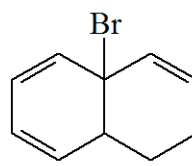
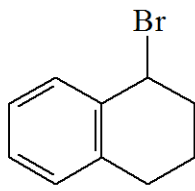
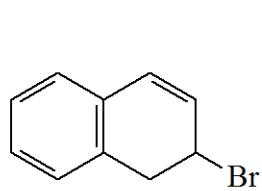
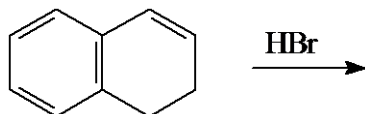
22. A compound X, C_8H_{10} , is oxidized to benzoic acid with potassium dichromate, $K_2Cr_2O_7$, in sulfuric acid. What is compound X?

- A. *para*-xylene
B. propylbenzene
C. styrene
D. ethylbenzene

23. Acid-catalyzed dehydration of *cis*-2-phenylcyclopentanol gives:

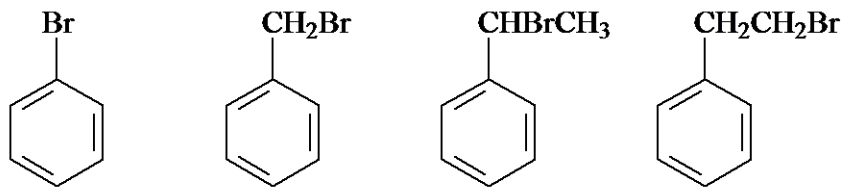
- A. 1-phenylcyclopentene
B. phenylcyclopentane
C. 4-phenylcyclopentene
D. 1-phenylcyclopentanol

24. Predict the major organic product in the following reaction.



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

25. Which of the following has the fastest rate of S_N1 hydrolysis in aqueous acetone?



I. II. III. IV.

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

26. Select the best method to convert styrene, $C_6H_5CH=CH_2$, to 2-phenylethanol with minimal by-product formation.

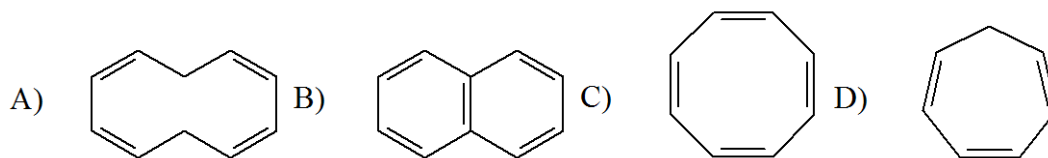
- A) H_2O, H_2SO_4
 B) (1) BH_3-THF (2) $H_2O_2, NaOH$
 C) (1) HBr (2) KOH, H_2O
 D) (1) $HBr, peroxides$ (2) $NaOH, H_2O$

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

27. Which of the following would be a correct number of π electrons for a planar, monocyclic, completely conjugated polyene to be aromatic?

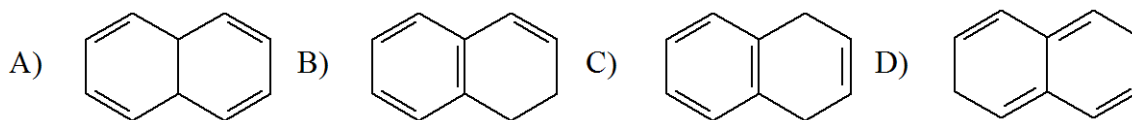
- A. 3
 B. 8
 C. 18
 D. 24

28. Which of the following is an aromatic hydrocarbon?



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

29. Which of the following has the lowest heat of reaction on catalytic hydrogenation? (4 moles of H_2 per mole of hydrocarbon)



- A. A

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

30. In which of the following are carbon-carbon bond lengths arranged in the correct order?

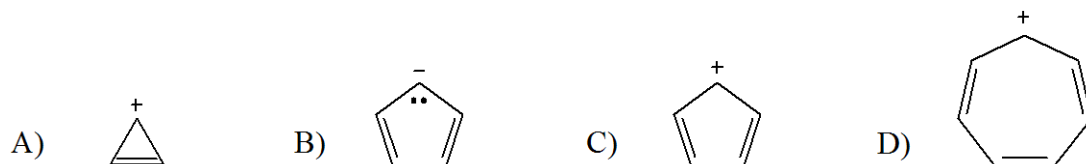
<u>Shortest</u>		<u>Longest</u>
A) benzene	ethylene	cyclohexane
B) ethylene	cyclohexane	benzene
C) cyclohexane	benzene	ethylene
D) ethylene	benzene	cyclohexane

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

31. Benzene has _____ π molecular orbitals (bonding and antibonding), and the lowest _____ molecular orbitals are filled with electrons in the ground state.

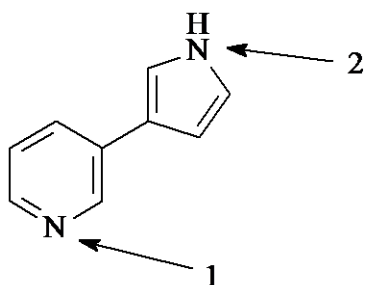
- A. three, three
- B. six, two
- C. six, three
- D. twelve, six

32. Which of the following ions has a ground state which is predicted to be a diradical by simple molecular orbital theory?



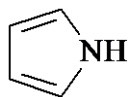
- A. A
- B. B
- C. C
- D. D

33. Identify the site of protonation when one equivalent of HCl is added to the compound below.



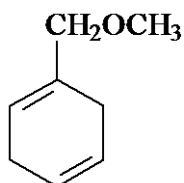
- A. N-1
- B. N-2
- C. both N-1 and N-2 (about 50% each)
- D. neither N-1 or N-2, the compound is not basic

34. What is the hybridization of the nitrogen atom in pyrrole?



- A. sp
- B. sp^2
- C. sp^3
- D. $2p$

35. Starting with toluene, which sequence of reactions below works best to prepare the following cyclohexadiene compound?



- A) toluene $\xrightarrow[\text{CH}_3\text{OH}]{\text{Na, NH}_3}$ $\xrightarrow[\text{CCl}_4]{\text{NBS, heat}}$ $\xrightarrow[\text{CH}_3\text{OH}]{\text{NaOCH}_3}$
- B) toluene $\xrightarrow[\text{CCl}_4]{\text{NBS, heat}}$ $\xrightarrow[\text{CH}_3\text{OH}]{\text{NaOCH}_3}$ $\xrightarrow[\text{CH}_3\text{OH}]{\text{Na, NH}_3}$
- C) toluene $\xrightarrow[\text{CH}_3\text{OH}]{\text{NaOCH}_3}$ $\xrightarrow[\text{CH}_3\text{OH}]{\text{Na, NH}_3}$ $\xrightarrow[\text{CCl}_4]{\text{NBS, heat}}$

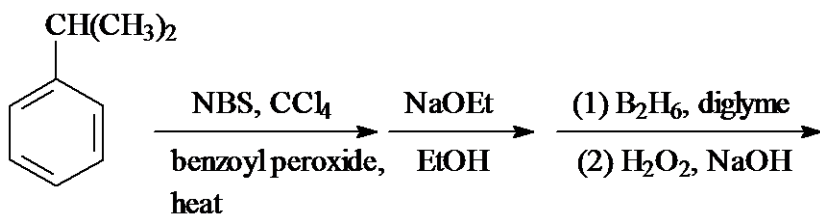
D) all the above would be good syntheses

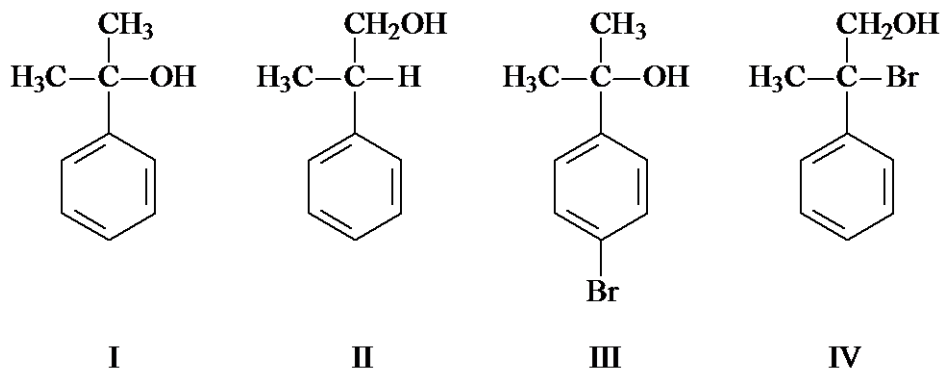
- A. A
- B. B
- C. C
- D. D

36. Which of the following isomers would you predict has the highest heat of hydrogenation?

- A. 1-ethyl-1,4-cyclohexadiene
- B. 3-ethyl-1,4-cyclohexadiene
- C. 1-ethyl-1,3-cyclohexadiene
- D. 5-ethyl-1,3-cyclohexadiene

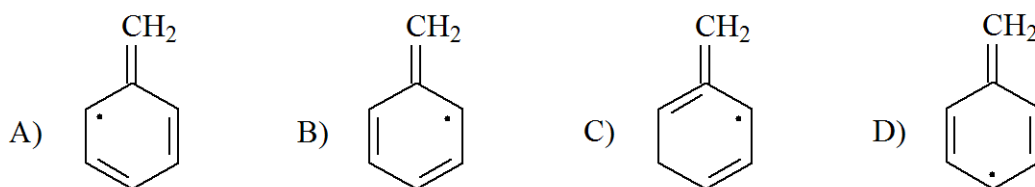
37. Which of the following is the product from the reaction sequence shown below?





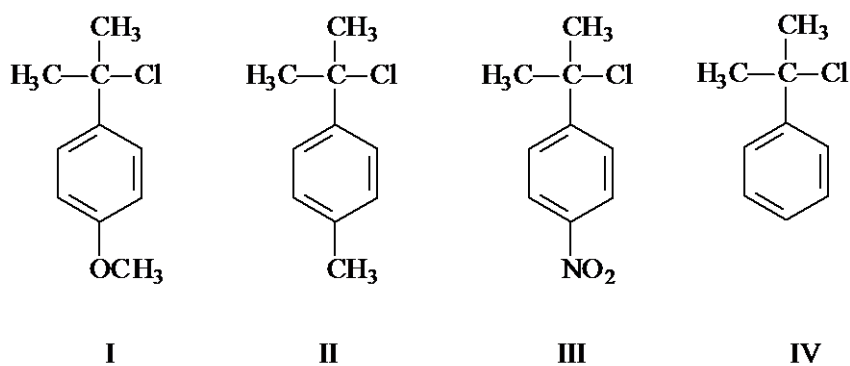
- A. I
 B. II
 C. III
 D. IV

38. Which one of following is not a resonance form of the benzyl free radical?



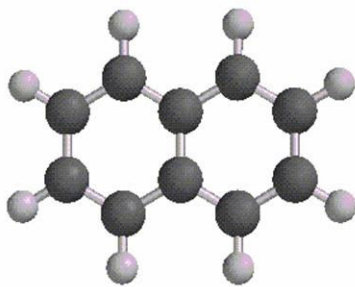
- A. A
 B. B
 C. C
 D. D

39. Which one of the following compounds has the fastest S_N1 reaction rate with H_2O in acetone?



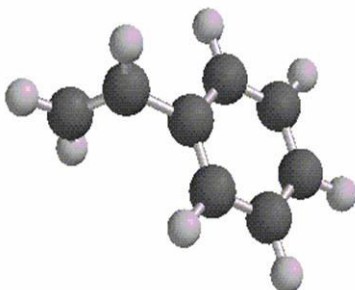
- A. I
 B. II
 C. III
 D. IV

40. How many π electrons are there in the following polycyclic aromatic hydrocarbon?



- A. 6
- B. 8
- C. 10
- D. 14

41. In the following conformation of styrene, the alignment of the $-\text{CH}=\text{CH}_2$ group results in:



- A. maximum conjugation and maximum steric hindrance with the C_6H_5 group.
- B. maximum conjugation and minimal steric hindrance with the C_6H_5 group.
- C. minimal conjugation and maximum steric hindrance with the C_6H_5 group.
- D. minimal conjugation and minimal steric hindrance with the C_6H_5 group.

42. How many isomeric tetrachlorobenzenes are there?

- A. two
- B. three
- C. four
- D. five

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1. B
2. C
3. B
4. C
5. D
6. B
7. C
8. C
9. C
10. B
11. B
12. A
13. D
14. B
15. B
16. A
17. B
18. C
19. A
20. D
21. B
22. D
23. A
24. B
25. C
26. B
27. C
28. B
29. B
30. D
31. C
32. C
33. A
34. B
35. B
36. B
37. B
38. C
39. A
40. C
41. D
42. B