General and Miscelleneous

1. How many electrons occupy the bonding molecular orbitals of a CN triple bond?

○ A) 2 ○ B) 4 ○ C) 6 ○ D) 8

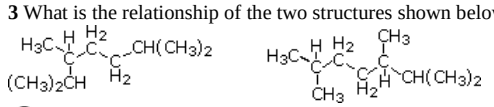
---

2. Which of the following species is not amphoteric ?

○ A) NH_3 ○ B) HF ○ C) $NH_4^{(+)}$ ○ D) $HCO_3^{(-)}$

---

3 What is the relationship of the two structures shown below?



○ A) they are identical.
○ B) they are conformations of the same structure
○ C) they are constitutional isomers.
○ D) they are different compounds with different compositions

---

4 Which of the following molecules will **not** have a dipole moment?

○ A) CH_3Cl
○ B) CH_3OCH_3
○ C) CH_2Cl_2
○ D) CCl_4

---

5 Which of the following molecules has a dipole moment?

○ A) CBr_4
○ B) $CH_2=CH_2$
○ C) BF_3
○ D) SO_2

---

6 Which of the following molecules has a linear shape?

○ A) NH_3
○ B) H_2S
○ C) CO_2
○ D) H_2CO

---

7 Which of the following intermediates is pyramidal in shape?

○ A) $H_3C(+)$
○ B) H_2C**:**
○ C) H_3C**:**$(-)$
○ D) HC≡C**:**$(-)$

---

8 In which compound does carbon have the highest oxidation state?

○ A) CH_4
○ B) HCN
○ C) H_2CO
○ D) CH_2Cl_2

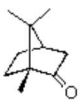
---

9 Which of the following statements applies to a $C_{10}H_{14}O_2$ compound?

○ A) it may have 2 double bonds and 2 rings
○ B) it may have 3 double bonds and 0 rings
○ C) it may have 1 triple bond and 3 rings
○ D) it may have 0 double bonds and 3 rings

---

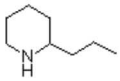
10 What functional group is present in the terpene camphor?



○ A) hydroxy
○ B) carboxy
○ C) carbonyl
○ D) oxy

---

11 What functional class is represented by the alkaloid coniine?



- A) amine
- B) imine
- C) amide
- D) nitrile

---

12 Which of the following compounds would be considered an electrophilic reagent?

- A) NH_3
- B) Br_2
- C) CH_3OH
- D) NH_2OH

---

13 Which of the following compounds would you expect to be most soluble in water?

- A) CH_2Cl_2
- B) C_6H_{12} (cyclohexane)
- C) CH_3CH_2OH
- D) $C_2H_5OC_2H_5$

---

14 The following compounds have similar molecular weights. Which has the highest boiling point?

- A) $CH_3CH{=}O$
- B) C_2H_5OH
- C) CH_3OCH_3
- D) $CH_3CH_2CH_3$

---

15 Which of the following compound pairs are constitutional isomers?

- A) $CH_3CH_2OCH_3$ and CH_3CH_2CHO
- B) CH_3CH_2CHO and $CH_3CH_2CH_2OH$
- C) $CH_3COCH_2CH_3$ and $CH_3CH_2COCH_3$
- D) $CH_3CH_2CH_2CHO$ and $CH_3COCH_2CH_3$

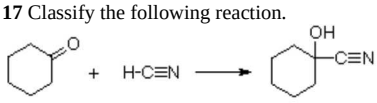
---

16 Which of the following compounds may be classed as a protic solvent?

- A) tert-butanol
- B) diethyl ether
- C) n-hexane
- D) acetone

---

17 Classify the following reaction.



- A) substitution
- B) addition
- C) elimination
- D) rearrangement

---

18 Which of the following is **not** a nucleophile?

- A) H_2O
- B) CH_3NH_2
- C) C_2H_5SH
- D) C_6H_{12} (cyclohexane)

---

19 Which of the following is **not** an electrophile?

- A) $C_2H_5OC_2H_5$
- B) BF_3
- C) $[CH_3]_3C^{(+)}$
- D) HOCl

---

20 Which Lewis formula is the best representation of N_2O?

---

21 Which of the following compounds has a C-H bond with the lowest bond dissociation energy?

- A) C_2H_6
- B) C_6H_6
- C) C_2H_2
- D) $CH_3CH{=}CH_2$

---

22 In order for a reagent to behave as a nucleophile it **must** have ...

- A) an overall positive charge.
- B) an overall negative charge.
- C) a non-bonding electron pair.
- D) a nitrogen or sulfur atom.

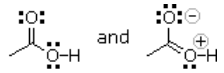
---

23 The H–C–O bond angle in $H_2C{=}O$ (formaldehyde) is approximately .....

- A) 90º
- B) 109º.
- C) 120º.
- D) 180º.

---

24 Which of the following structural pairs represents contributors to a resonance hybrid?

- A  and
- B  and 
- C  and 
- D  and 

---

25 Which of the following molecular formulas is reasonable for a stable compound?

- A) $C_8H_{14}O_2Cl$
- B) $C_6H_{14}Br_2$
- C) $C_7H_{10}NF$
- D) $C_{30}H_{54}N_2Cl$

---

26 What formal charges are present in the molecule $C_6H_5C{\equiv}N\text{-}O$?
(all heavy atoms have a valence shell octet, and C_6H_5- is a phenyl group)

- A) N is -1 and C is +1
- B) N is +1 and C is -1
- C) O is -1 and C is +1
- D) O is -1 and N is +1

---

27 Which statement about members of a homologous series is true ?

- A) they are all constitutional isomers.
- B) they are always hydrocarbons.
- C) each differs from its nearest neighbors by 14 amu.
- D) they may also be classified as tautomers.

---

28 How many structurally distinct (different) sets of hydrogens are present in $(CH_3)_3CCH_2OCH_3$?

- A) 2
- B) 3
- C) 4
- D) 8

---

29 The pK_as of H_2CO_3 are 6.4 & 10.3. The pK_a of HOBr is 8.7. If equimolar amounts of Na_2CO_3 and HOBr are dissolved in water what will be the predominant anionic species in the resulting solution?

- A) HCO_3^{-1} and BrO^{-1}
- B) CO_3^{-2}, Br^{-1} and OH^{-1}
- C) HCO_3^{-1} and Br^{-1}
- D) CO_3^{-2} and 2 BrO^{-1}

---

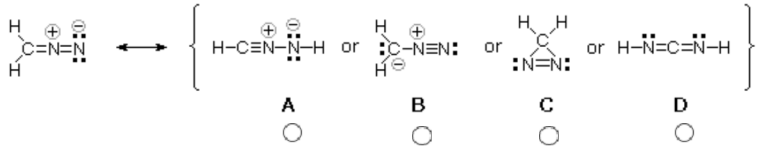
30 Which of the following is a conjugate base of CH_3NHOH?

- A) CH_3NH^{-1}
- B) CH_3NHO^{-1}

○ C) $CH_3NH_3^{+1}$
○ D) $CH_2{=}NOH^{-1}$

---

31 A Lewis formula for diazomethane, CH_2N_2, is shown on the left below.
Which of the formulas within the brackets would be considered a proper resonance contributor to this structure ?



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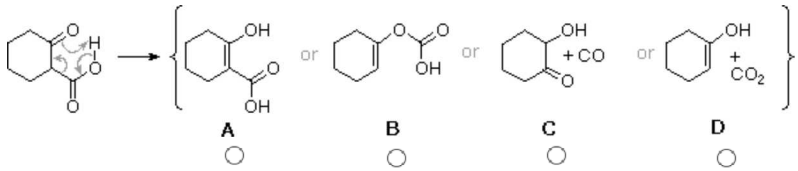
32 The curved arrows in the formula on the left represent a chemical reaction.
Which of the formulas within the brackets would constitute the product(s) from this reaction ?



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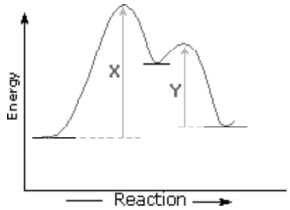
33 Which of the descriptions (A to D) correctly describe the following energy diagram?



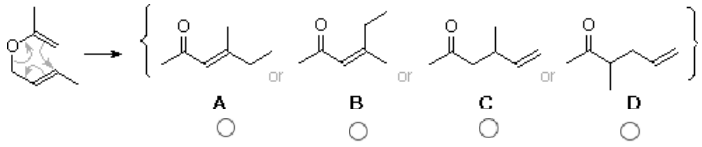
○ A) A two-step exothermic reaction having an activation energy = **X**
○ B) A two-step endothermic reaction having an activation energy = **Y**
○ C) A two-step exothermic reaction having an activation energy = **Y**
○ D) A two-step endothermic reaction having an activation energy = **X**

---

34 Which of the following series contain a free radical, a nucleophile and an electrophile?
○ A) $Br\cdot$ BF_3 NH_3
○ B) NH_3 NO_2^+ Br_2
○ C) H_2O $Cl\cdot$ NH_3
○ D) Cl_2 CH_4 NH_3

---

35 The curved arrows in the formula on the left represent a chemical reaction.
Which of the formulas within the brackets would constitute the product(s) from this reaction ?



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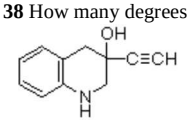
36 Which of the following species has a planar molecular configuration?
○ A) SO_3^{-2}
○ B) SO_3
○ C) $SOCl_2$
○ D) SO_2Cl_2

---

37 Which of the following compounds does **not have** a planar molecular configuration?
○ A) $H_2C{=}CH_2$
○ B) $H_2C{=}CH{-}C{\equiv}CH$
○ C) $H_2C{=}C{=}CH_2$
○ D) $H_2C{=}C{=}C{=}CH_2$

---

38 How many degrees of unsaturation does the following structure have?

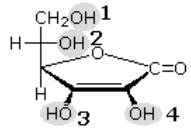


○ A) 4
○ B) 5
○ C) 6
○ D) 7

---

39 The structural formula for vitamin C is shown below

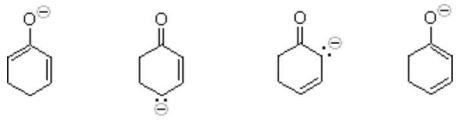
Of the four hydroxyl groups, identified by shaded circles, which is most acidic?



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

---

40 Which of the following structures **is not** a resonance contributor to the hybrid defined by the other three?



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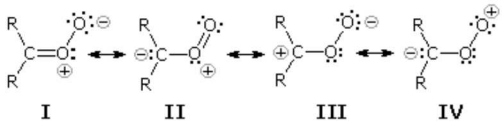
41 The following structures are resonance contributors for a reactive intermediate formed during ozonolysis of alkenes.
Identify the most energetically favorable and the least favorable contributors?



- A) III is most favorable & II is least favorable
- B) I is most favorable & IV is least favorable
- C) II is most favorable & IV is least favorable
- D) I is most favorable & II is least favorable

---

42 How would the bond strength of the C:C double bond in an alkene compare to that of a C:C single bond in the corresponding alkane?

- A) The double bond would have the same strength as the single bond.
- B) The double bond would be stronger than, but less than twice as strong as the single bond.
- C) The double bond would have exactly twice the strength of the single bond.
- D) The double bond would have more than twice the strength of the single bond.

---

43 Which of the following cations is most stable?

- A) FH_2^+
- B) OH_3^+
- C) NH_4^+
- D) CH_5^+

---

44 The toxic environmental pollutant dioxin is 44.8% carbon, 1.25% hydrogen and 44.0% chlorine. Its molecular weight is 320±10
What is the molecular formula of dioxin?

- A) $C_{10}H_8O_4Cl_4$
- B) $C_{12}H_6O_2Cl_4$
- C) $C_6H_2OCl_2$
- D) $C_{12}H_4O_2Cl_4$

---

45 Which of the following covalent compounds does not have any formally charged atoms?

- A) $(CH_3)_3NO$
- B) CH_2=N=N
- C) CH_3-O-N=O
- D) $CH_3C{\equiv}NO$

---

46 Which of the following statements **is not** generally correct?

- A) endothermic reactions have larger energies of activation than exothermic reactions
- B) the rate of a reaction is proportional to its activation energy
- C) the rate of a reaction generally increases as the temperature is raised
- D) all reactions in which bonds are broken and formed have a significant activation energy

---

47 Which of the following compounds has no isomer?

- A) $CH_3CH_2CH_2Cl$
- B) CH_3CHO
- C) CH_2=CHCl

○ D) $ClCH_2CH_2Cl$

---

48 Which of the following statements about carbon **is not** correct?

○ A) carbon forms strong covalent bonds to itself, allowing chains and rings to be made.
○ B) carbon expands its valence shell to accomodate more than eight electrons and thus forms double and triple bonds.
○ C) carbon forms strong covalent bonds to elements like nitrogen and oxygen because it does not have lone pairs of valence electrons to destabilize the bonds.
○ D) carbon and hydrogen have similar electronegativity and form strong bonds to each other, thus avoiding the high reactivity shown by metal hydrides.

Check Answers

Reset/Clear

View Answers

You must correctly answer some of these questions before viewing the answers.

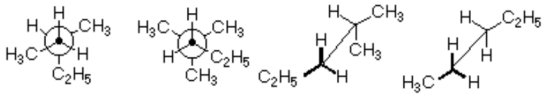
Alkanes, Alkenes, Alkynes and their Alicyclic Couterparts

1. What is the IUPAC name for $CH_3CH_2C(CH_3)_2CH_2CH(CH_3)_2$?

- A) 3,3,5-trimethylhexane
- B) 2,2,5-trimethylhexane
- C) 2,4,4-trimethylhexane
- D) 1,1,3,3-tetramethylpentane

---

2. Which of the following conformational structures is 2-methylpentane ?



A B C D

---

3 The alkane $CH_3CH_2C(CH_3)_2CH_2CH(CH_3)_2$ has how many 1º, 2º. 3º & 4º carbon atoms?

	1º	2º	3º	4º
A)	4	2	2	1
B)	5	1	2	1
C)	5	2	1	1
D)	6	1	1	1

---

4 There are four constitutional isomers having the formula C_4H_9Cl
Which of the following would be a correct IUPAC name for one of these isomers?

- A) 1-chloro-2-methylpropane
- B) 3-chlorobutane
- C) 2-chloro-2-methylbutane
- D) 1-chloro-3-methylpropane

---

5 Which isomer of hexane has only two different sets of structurally equivalent hydrogen atoms.?

- A) 2,2-dimethylbutane
- B) 2-methylpentane
- C) 3-methylpentane
- D) 2,3-dimethylbutane

---

6 Limiting your answer to cycloalkanes and ignoring stereoisomers, how many C_6H_{12} constitutional isomers are there?

- A) 6
- B) 9
- C) 11
- D) 13

---

7 The IUPAC name for $(CH_3)_2CHCH(CH_3)CH_2CH=CH_2$ is ...

- A) 4,5-dimethyl-1-hexene
- B) 4,5,5-trimethyl-1-pentene
- C) 2,3-dimethyl-5-hexene
- D) 4-methyl-4-isopropyl-1-butene

---

8 How many isomeric pentenes (C_5H_{10}) exist? (count stereoisomers as well)

- A) 4
- B) 5
- C) 6
- D) 7

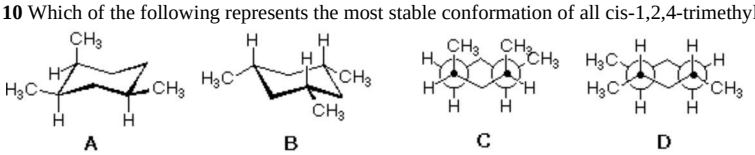
---

9 The preferred conformation of *cis*-1,3-dimethylcyclohexane is ...

- A) chair--diaxial
- B) chair--diequatorial
- C) chair--one axial / one equatorial
- D) boat--mixed orientations

---

10 Which of the following represents the most stable conformation of all cis-1,2,4-trimethylcyclohexane?



A B C D

○ ○ ○ ○

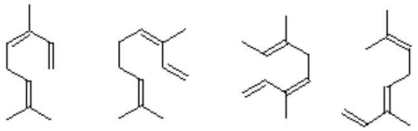
---

11 A C_6H_{12} compound reacts with ozone to yield a single C_3H_6O product. Gas phase free radical bromination of the hydrocarbon gives a single $C_6H_{11}Br$ product. A likely identification of this compound is ..

○ A) cyclohexane
○ B) cyclohexene
○ C) 3-hexene
○ D) 2,3-dimethyl-2-butene

---

12 The terpene ocimene has the IUPAC name (3E)-3,7-dimethyl-1,3,6-octatriene, what is the structural formula of this compound?



○ ○ ○ ○

---

13 The most typical reaction of simple alkenes is ...

○ A) electrophilic substitution
○ B) nucleophilic substitution
○ C) electrophilic addition
○ D) nucleophilic addition

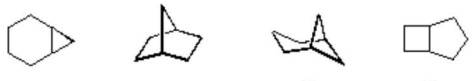
---

14 Which of the following dimethylcyclobutanes is chiral ?

○ A) *trans*-1,2-dimethylcyclobutane
○ B) *cis*-1,2-dimethylcyclobutane
○ C) *trans*-1,3-dimethylcyclobutane
○ D) *cis*-1,3-dimethylcyclobutane

---

15 What is the structure of bicyclo[3.1.1]heptane?



○ ○ ○ ○

---

16 Which of the following C_6H_{12} isomers has the largest heat of combustion?

○ A) cyclohexane
○ B) methylcyclopentane
○ C) ethylcyclobutane
○ D) propylcyclopropane

---

17 The radical halogenation of 2-methylpropane gives two products: $(CH_3)_2CHCH_2X$ (minor) and $(CH_3)_3CX$ (major)
Chlorination gives a larger amount of the minor product than does bromination, Why?

○ A) Bromine is more reactive than chlorine and is able to attack the less reactive 3º C-H.
○ B) Bromine atoms are less reactive (more selective) than chlorine, and preferentially attack the weaker 3º C-H bond.
○ C) The methyl groups are more hindered to attack by the larger bromine atom.
○ D) Bromination is reversible and the more stable 3º-alkyl bromide is formed exclusively.

---

18 A tertiary carbocation (carbonium ion) is more stable than either a secondary or primary carbocation because ...

○ A) it carries three positive charges
○ B) it has a pyramidal configuration
○ C) it has a trigonal planar configuration
○ D) it possesses three electron-donating substituent groups

---

19 Which of the following is **not** an electrophile?

○ A) $C_2H_5OC_2H_5$
○ B) BF_3
○ C) $[CH_3]_3C^{(+)}$
○ D) HOCl

---

20 Which of the following olefins would you expect to react **most rapidly** with concentrated sulphuric acid ?

○ A) $H_2C{=}CH_2$
○ B) $(CH_3)_2C{=}CH_2$
○ C) $Cl_2C{=}CCl_2$

○ D) $CF_3CH=CH_2$

---

21 Which compound is a likely product from addition of Cl_2 to 1-butene?

○ A) $CH_3CH_2CH_2CHCl_2$
○ B) $CH_3CH_2CHClCH_2Cl$
○ C) $ClCH_2CH_2CH_2CH_2Cl$
○ D) $CH_3CH_2CCl_2CH_3$

---

22 The product from OsO_4 hydroxylation of *trans*-2-butene will be ...

○ A) achiral
○ B) optically active
○ C) racemic
○ D) a meso compound

---

23 The product from bromine addition to *trans*-2-butene will be ...

○ A) optically active
○ B) racemic
○ C) a meso compound
○ D) chiral

---

24 Addition of 1 equivalent of bromine to 2,4-hexadiene at 0º C gives 4,5-dibromo-2-hexene plus an isomer.
Which of the following is that isomer?

○ A) 5,5-dibromo-2-hexene
○ B) 2,5-dibromo-3-hexene
○ C) 2,2-dibromo-3-hexene
○ D) 2,3-dibromo-4-hexene

---

25 How many sp hybridized carbon atoms are present in a molecule of 3-methyl-4-vinyl-1,2-heptadien-5-yne?

○ A) 2
○ B) 3
○ C) 4
○ D) 5

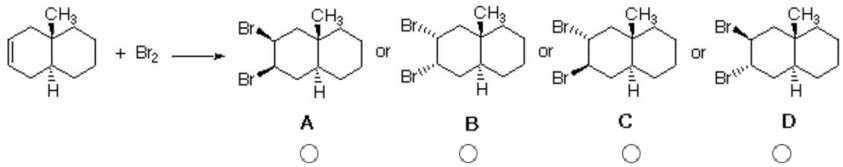
---

26 Treatment of 1-methylcyclohexene with an ether solution of diborane (B_2H_6), followed by reaction with alkaline H_2O_2 produces what product?

○ A) 1-methylcyclohexanol
○ B) *cis*-1-methylcyclohexane-1,2-diol
○ C) *cis*-2-methylcyclohexanol
○ D) *trans*-2-methylcyclohexanol

---

27 Which of the following will be the kinetically favored product from the depicted reaction ?



○ ○ ○ ○

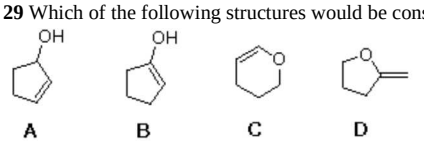
---

28 Two C_4H_6 isomers give the same C_4H_8O product from $HgSO_4$ catalyzed hydration in aqueous acid.
However, these isomers give different $C_4H_6Br_4$ products with excess bromine.
What are these isomeric hydrocarbons?

○ A) cyclobutene and methylenecyclopropane
○ B) 1,2-butadiene and 1,3-butadiene
○ C) 1-butyne and 2-butyne
○ D) 2-butyne and cyclobutene

---

29 Which of the following structures would be considered an enol tautomer of cyclopentanone?



○ ○ ○ ○

---

30 Two C_5H_8 isomers undergo catalytic (Pt) hydrogenation to form the same C_5H_{10} product. On ozonolysis followed by oxidative workup (H_2O_2), one isomer gave a $C_5H_8O_4$ diacid, while the other isomer gave a $C_5H_8O_3$ ketoacid.
Which of the following isomeric pairs correspond to this evidence?

○ A) cyclopentene and 1-pentyne

B) cyclopentene and 1-methylcyclobutene
C) 1-methylcyclobutene and 3-methylcyclobutene
D) cyclopentene and 3-methylcyclobutene

---

31 Considering that the angles of a regular pentagon are 108º, why is cyclopentane not planar?
A) all the carbons are sp^2 hybridized, so there is considerable angle strain.
B) The C-C bonds are formed by overlap of p-orbitals, so the 90º angle results in large angle strain.
C) The cyclic overlap of bonding orbitals results in anti-aromaticity destabilization.
D) The five C-C bonds have eclipsing strain.

---

32 Which reaction conditions would best convert 3-hexyne to *cis*-3-hexene?
A) Pt catalyst and H_2.
B) Lindlar's Pd catalyst and H_2.
C) Na in liquid NH_3.
D) $NaNH_2$ in liquid NH_3.

---

33 Reaction of 1-hexene with NBS (N-bromosuccinimide) forms two isomeric bromohexenes, one of which is 3-bromo-1-hexene.
Which of the following is the other isomer?
A) 1-bromo-2-hexene.
B) 6-bromo-1-hexene.
C) 1-bromo-1-hexene.
D) 2-bromo-1-hexene.

---

34 A C_6H_{10} hydrocarbon forms an insoluble silver salt when treated with silver nitrate in ethanolic ammonia.
Acid catalyzed hydration with a $HgSO_4$ catalyst generates a single $C_6H_{12}O$ ketone, and pemanganate oxidation yields a $C_5H_{10}O_2$ carboxylic acid
This compound is most likely which of the following?
A) cyclohexene.
B) methylenecyclopentane.
C) 1-hexyne.
D) 3-hexyne.

---

35 Peroxide induced reaction of carbon tetrachloride with 1-butene produces which of the following?
A) 1,1,1,3-tetrachloropentane.
B) 1,1,1,2-tetrachloropentane.
C) 1-chloro-2-trichloromethylbutane.
D) 1,1-dichloro-2-ethylcyclopropane.

---

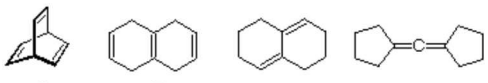
36 Which of the following isomeric hexenes will have the smallest heat of hydrogenation?
A) 4-methyl-1-pentene.
B) (E)-4-methyl-2-pentene.
C) (Z)-4-methyl-2-pentene.
D) 2-methyl-2-pentene.

---

37 A C_8H_{14} hydrocarbon (**X**) is reduced by sodium in liquid ammonia to a single C_8H_{16} product (**Y**).
Both of these compounds undergo hydrogenation (Pt catalyst) to give 2,5-dimethylhexane.
Ozonolysis of Y with an oxidative workup produces a single $C_4H_8O_2$ carboxylic acid.
Reaction of Y with perbenzoic acid ($C_6H_5CO_3H$) gives a chiral $C_8H_{14}O$ product, but reaction with bromine gives an achiral $C_8H_{14}Br_2$ product
What are X and Y?
A) X is 2,5-dimethyl-3-hexyne ; Y is *cis*-2,5-dimethyl-3-hexene.
B) X is 2,5-dimethyl-3-hexyne ; Y is *trans*-2,5-dimethyl-3-hexene.
C) X is 2.5-dimethyl-1,5-hexadiene ; Y is 2,5-dimethyl-3-hexyne.
D) X is 2,5-dimethyl-2,4-hexadiene ; Y is *cis*-2,5-dimethyl-3-hexene.

---

38 Which of the following compounds has two or more conjugated double bonds?



A B C D

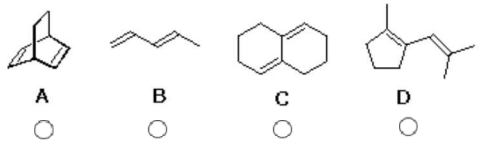
---

39 What reagent(s) would best achieve conversion of 3,3-dimethyl-1-butyne to the aldehyde $(CH_3)_3CCH_2CHO$?
A) $H_3O^{(+)}$ and catalytic $Hg^{(+2)}$
B) **(i)** R_2BH in ether ($R=C_5H_{11}$)
(ii) H_2O_2 and aqueous NaOH
C) $KMnO_4$ in aqueous NaOH

○ D) **(i)** HOBr
(ii) aqueous NaOH

---

40 Which of the following dienes would best serve as a diene in a Diels-Alder reaction?



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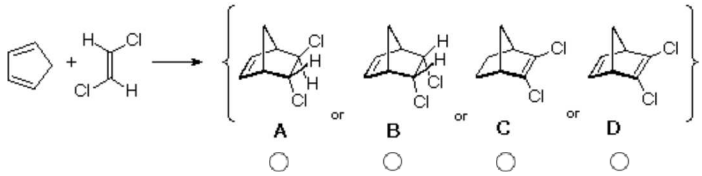
41 Which of the following is the most likely product of this Diels-Alder reaction?



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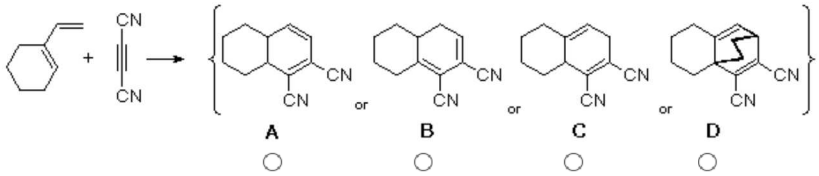
42 Which of the following is the most likely product of this Diels-Alder reaction?



---

43 Reaction of 1,1-dibromopentane with three equivalents of $NaNH_2$ in ether is followed by treatment with 0.1M HCl at 0° C.
What is the product?

○ A) cyclopentene.
○ B) 1,2-pentadiene.
○ C) 2-pentyne.
○ D) 1-pentyne.

---

44 Which of the following reagents and conditions would best serve to convert 1-butyne to 1,1-dibromobutane?

○ A) 2 equivalents of HBr, no peroxides.
○ B) 2 equivalents of HBr, with peroxides.
○ C) 1 equivalent of Br_2.
○ D) 2 equivalents of Br_2 followed by i equivalent of KOH.

---

45 What is the relative rate of addition of HBr to **I**: 1,3-pentadiene; **II**: 1,4-pentadiene; and **III**: 1-pentyne?

○ A) I > II > III.
○ B) III > II > I.
○ C) II > I > III.
○ D) III > I > II.

---

46 A chiral C_6H_{12} hydrocarbon undergoes catalytic hydrogenation to yield an achiral C_6H_{14} product. What is the starting compound?

○ A) cis-2-hexene
○ B) 3-methyl-2-pentene
○ C) 4-methyl-2-pentene
○ D) 3-methyl-1-pentene

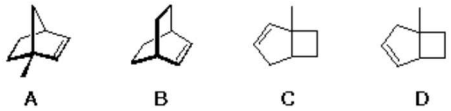
---

47 Reaction of 3,3,6,6-tetramethyl-1,4-cyclohexadiene, first with excess aqueous mercuric acetate, then followed by sodium borohydride reduction, produces a mixture of isomeric $C_{10}H_{20}O_2$ alcohols.
Excluding enantiomers, how many isomeric products may be formed in this reaction?

○ A) 2
○ B) 4
○ C) 6
○ D) 8

---

48 A C_8H_{12} chiral hydrocarbon, **X**, is reduced by catalytic hydrogenation to an achiral C_8H_{14} compound.
Ozonolysis of **X** (H_2O_2 workup) gave a chiral $C_8H_{12}O_4$ dicarboxylic acid.
Which of the following could be **X** ?



○ ○ ○ ○

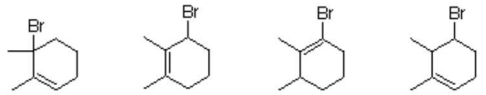
---

49 Which of the following reactions of cyclohexene may be considered an oxidation?

○ A) addition of hydrogen (Pt catalyst) to give cyclohexane.
○ B) addition of HBr to give bromocyclohexane
○ C) epoxidation by perbenzoic acid to give cyclohexene oxide
○ D) mercuric acetate catalyzed hydration to give cyclohexanol

---

50 Addition of HBr to 2,3-dimethyl-1,3-cyclohexadiene may occur in the absence or presence of peroxides.
In each case two isomeric $C_8H_{13}Br$ products are obtained.
Which of the following is a common product from both reactions?



A ○ B ○ C ○ D ○

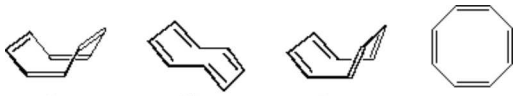
---

51 What structural change takes place when an alkene undergoes a Simmons-Smith reaction?

○ A) addition of ethene gives a cyclobutane derivative.
○ B) the double bond is shifted to a more substituted location.
○ C) the double bond is converted to a triple bond.
○ D) a methylene group is added to give a cyclopropane derivative.

---

52 Cyclooctatetraene, C_8H_8, appears to be a conjugated annulene.
In addition to the planar configuration, three non-planar structures may be considered, all of which are shown below.
Which of these is most likely to be the favored conformation? note that D is planar.



A ○ B ○ C ○ D ○

---

53 Which one of the following compounds contains the greatest number of sp^2 hybridized carbon atoms?

○ A) 1,4-Cycloheptadiene
○ B) 2,5-dimethyl-2,3,4-hexatriene
○ C) Phenylacetylene
○ D) 1,1-diallyl-3,3-divinylcyclobutane

---

54 Which one of the following compounds contains the greatest number of sp hybridized carbon atoms?

○ A) 1,4-Cyclooctadiene
○ B) 2,5-dimethyl-2,3,4-hexatriene
○ C) Phenylacetylene
○ D) 1,1-diallyl-3,3-divinylcyclobutane

---

55 Which one of the following compounds contains the greatest number of sp^3 hybridized carbon atoms?

○ A) 1,4-Cyclooctadiene
○ B) 2,5-dimethyl-2,3,4-hexatriene
○ C) Phenylacetylene
○ D) 1,1-diallyl-3,3-divinylcyclobutane

---

56 Which of the following isomers has the lowest heat of combustion?

○ A) cis-1,2-dimethylcyclohexane
○ B) trans-1,2-dimethylcyclohexane
○ C) cis-1,3-dimethylcyclohexane
○ D) trans-1,3-dimethylcyclohexane

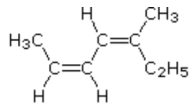
---

57 Compound Z, C_8H_{14}, reacts with excess hydrogen and a Pt catalyst to give 2,5-dimethylhexane as the only product.
Z diplays three ^{13}C nmr signals, all at higher field than 100 ppm, and does not absorb in the UV at wavelengths greater than 200 nm.
Oxidation of Z by either ozone or potassium permanganate produces a single $C_4H_8O_2$ carboxylic acid. Deduce the structure of Z.

○ A) 2,5-dimethyl-3-hexyne
○ B) trans-2,5-dimethyl-3-hexene
○ C) cis-2,5-dimethyl-3-hexene
○ D) 2,5-dimethyl-2,4-hexadiene

---

58 Which of the following is the correct configurational prefix for the following diene?



A (2E,4E) **B** (2Z,4Z) **C** (2Z,4E) **D** (2E,4Z)

Check Answers Reset/Clear View Answers

Alkyl Halides, Alcohols, Ethers and Epoxides

1. What is the IUPAC name for $CH_3CHClCH(CH_3)CH_2CH_2CH_2CH_2Br$?

- A) 1-bromo-6-chloro-5-methylheptane
- B) 7-bromo-2-chloro-3-methylheptane
- C) 1-bromo-6-chloro-5,6-dimethylhexane
- D) 6-bromo-1-chloro-1,2-dimethylhexane

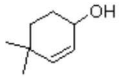
---

2. What is the IUPAC name for $(CH_3)_3CCH(OH)CH_2CH(OH)CH_2CH(CH_3)_2$?

- A) 1,1,1,6-tetramethyl-2,4-heptanediol
- B) 2,2,7-trimethyl-3,5-octanediol
- C) 2,2,6,6-tetramethyl-3,5-heptanediol
- D) 2,7,7-trimethyl-4,6-octanediol

---

3 What is a correct name for the following compound?



- A) 1,1-dimethyl-2-cyclohexenol
- B) 3,3-dimethyl-1-cyclohexen-6-ol
- C) 6,6-dimethyl-1-cyclohexen-3-ol
- D) 4,4-dimethyl-2-cyclohexenol

---

4 Which of the following is a chiral $C_5H_{12}O$ 1°-alcohol?

- A) 3-methyl-2-butanol
- B) 2-methyl-2-butanol
- C) 3-methyl-1-butanol
- D) 2-methyl-1-butanol

---

5 Which of the following reagents would you expect to react with bromocyclopentane by an S_N2 mechanism?

- A) C_2H_5OH
- B) $C_2H_5O^{(-)}\ K^{(+)}$
- C) NaCN
- D) $(CH_3)_3N$

---

6 Chloroethane, C_2H_5Cl, does not react with methanol under mild conditions.
What reagent could be added to the reaction mixture to increase the rate of substitution.?

- A) HCl (conc.)
- B) NaOH
- C) NH_4OH
- D) $AgNO_3$

---

7 Which of the following compounds is **unlikely to react** with sodium metal?

- A) $C_2H_5OC_2H_5$
- B) C_2H_5OH
- C) C_2H_5Br
- D) $C_2H_5NH_2$

---

8 The reaction of sodium ethoxide with iodoethane to form diethyl ether is classified as ...

- A) an electrophilic substitution
- B) a nucleophilic substitution
- C) a radical substitution
- D) an electrophilic addition

---

9 Compound **X** reacts with HI. The product of this reaction, when treated with KOH in ethanol, gives **Y** (an isomer of **X**).
Ozonolysis of **Y** (H_2O_2 workup) produces two compounds: a two carbon carboxylic acid, and a four carbon ketone.
What is **X**?

- A) 2-methyl-2-pentene
- B) 4-methyl-1-pentene
- C) 2,3-dimethyl-2-butene
- D) 3-methyl-1-pentene

---

10 The S_N2 reaction of 1-chloro-3-methylbutane with sodium methoxide is relatively slow, but can be accelerated by the addition of a small amount of NaI.
How is this catalysis best explained?

- A) The sodium cation helps pull off the chloride anion
- B) The iodide anion activates the methoxide nucleophile

C) S_N2 reaction of iodide ion converts the alkyl chloride to the more reactive alkyl iodide
D) The NaI changes the mechanism to S_N1

---

11 Which one of the following alcohols will be oxidized by Jones' reagent (CrO_3 in 50% sulphuric acid) to a ketone having the same number of carbon atoms ?
A) 1-methylcyclohexanol
B) 3,3-dimethylcyclopentanol
C) 3-methyl-1-hexanol
D) 3-ethyl-3-hexanol

---

12 What reagent would be suitable for distiguishing 1-methoxy-3-methyl-2-butene from its isomer 4-methyl-3-penten-1-ol?
A) bromine in methylene chloride
B) $KMnO_4$ in aqueous base
C) $AgNO_3$ in dilute NH_4OH
D) sodium metal suspended in hexane

---

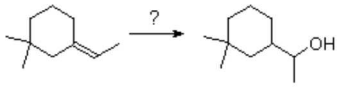
13 Synthesis of hexane-3,4-diol from *trans*-3-hexene may be accomplished in two ways:
(i) OsO_4 hydroxylation & **(ii)** $C_6H_5CO_3H$ epoxidation followed by NaOH opening of the epoxide ring.
Which of the following statements about the products from these reactions is correct?
A) the two methods giive the same product
B) **(i)** gives a chiral isomer, **(ii)** gives an achiral isomer
C) **(i)** gives an achiral isomer, **(ii)** gives a chiral isomer
D) two different isomers are formed, but both are chiral

---

14 Reaction of 1,4-dibromobutane with Mg turnings in ether gives the bis-Grignard reagent, $BrMgCH_2CH_2CH_2CH_2MgBr$.
What is the product from the reaction of meso-2,3-dibromobutane with Mg under the same conditions?
A) *trans*-2-butene
B) *cis*-2-butene
C) meso-$CH_3CH(MgBr)CH(MgBr)CH_3$
D) racemic-$CH_3CH(MgBr)CH(MgBr)CH_3$

---

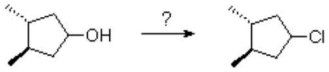
15 Which reagent(s) would best accomplish the following transformation?



A) H_3O^+ & heat
B) **(i)** $HgSO_4$ in H_2O **(ii)** $NaBH_4$
C) **(i)** B_2H_6 in ether **(ii)** H_2O_2 and base
D) **(i)** HOBr **(ii)** Mg in ether

---

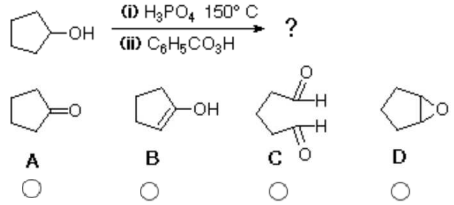
16 Which of the following reagents would **not** effect the following transformation?



A) KCl (5 molar solution)
B) HCl & $ZnCl_2$
C) $SOCl_2$
D) PCl_3

---

17 What will be the chief product from the following reaction sequence?



18

I $OH^{(-)}$ **II** $CH_3CO_2^{(-)}$ **III** $HO_2^{(-)}$ **IV** H_2O

The above molecules and ions are all nucleophiles. What is the relative order of their reactivity in an S_N2 reaction with ethyl bromide?
A) I > II > III > IV
B) IV> III > II > I
C) III > I > II > IV
D) II > III > IV > I

---

19 In the S_N2 reaction of cyanide ion with $(CH_3)_2CHCH_2CH_2X$ what is the relative order of reactivity for the following X substituents?

I X = F **II** X = Cl **III** X = Br **IV** X = I

- A) I > II > III > IV
- B) IV> III > II > I
- C) III > I > II > IV
- D) II > III > IV > I

---

20 Which of the following does **not** convert a 1°-hydroxyl group into a good leaving group for a S_N2 reaction?

- A) $SOCl_2$
- B) CH_3SO_2Cl
- C) PBr_3
- D) NaI

---

21 How is the following reaction best classified?

$(CH_3)_3CBr + (CH_3CH_2)_3N$ -----> $(CH_3)_2C{=}CH_2 + (CH_3CH_2)_3NH^{(+)}\ Br^{(-)}$

- A) S_N2 substitution
- B) E2 elimination
- C) electrophilic addition
- D) cationic rearrangement

---

22 Which of the following isomeric chlorides will undergo S_N2 substitution most resdily?

- A) 4-chloro-1-butene
- B) 1-chloro-1-butene (cis or trans)
- C) 1-chloro-2-butene (cis or trans)
- D) 2-chloro-1-butene

---

23 Which reagent would be best for achieving an E2 elimination of 3-chloropentane?

- A) C_2H_5ONa
- B) CH_3CO_2Na
- C) $NaHCO_3$
- D) NaI

---

24 Which reaction conditions would be best for the synthesis of isobutyl *sec*-butyl ether

$CH_3CH_2CH(CH_3)$-O-$CH_2CH(CH_3)_2$?

- A) $(CH_3)_2CHCH_2OH + H_2SO_4$ + heat
- B) $CH_3CH_2CH(CH_3)OH + H_2SO_4$ + heat
- C) $CH_3CH_2CH(CH_3)ONa + (CH_3)_2CHCH_2Br$
- D) $(CH_3)_2CHCH_2ONa + CH_3CH_2CH(CH_3)Br$

---

25 A chiral $C_5H_{10}O$ ether reacts with hot HI to give a $C_5H_{10}I_2$ product

Theatment of this with hot KOH in ethanol produces 1,3-pentadiene. What is the structure of the original ether?

A ○ B ○ C ○ D ○

---

26 A $C_7H_{13}Br$ compound reacts with KOH in ethanol to form 3-methylcyclohexene as the major product.

What is a likely structure for the starting alkyl bromide?

- A) *cis*-4-methylcyclohexyl bromide
- B) *trans*-3-methylcyclohexyl bromide
- C) *cis*-2-methylcyclohexyl bromide
- D) *trans*-2-methylcyclohexyl bromide

---

27 A synthesis of 2,5-dimethyl-2-hexanol from 2-methylpropene requires the formation of two four-carbon intermediates, **X** and **Y**.

These intermediates combine to give the desired product after the usual hydrolysis work-up.

Select appropriate methods of preparing **X** and **Y** from 2-methylpropene

- A) **X** add HBr, then react with Mg in ether **Y** add water, acid-catalysis
- B) **X** add HBr (peroxides), then react with Mg in ether **Y** react with $C_6H_5CO_3H$ in CH_2Cl_2
- C) **X** add HOBr **Y** add B_2H_6in ether, then NaOH
- D) **X** add HOBr **Y** add HBr (peroxides) ,then react with Mg in ether

---

28 All of the following alkyl bromides react by S_N2 substitution when treated with sodium cyanide in methanol.

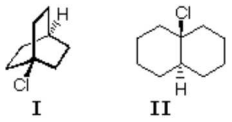
Which one **does not** undergo an inversion of configuration?

- A) (R)-1-bromo-2-methylbutane
- B) (S)-2-bromo-3-methylbutane
- C) (R)-1-bromo-3,3-dimethylcyclohexane

○ D) *cis*-4-ethyl-1-bromocyclohexane

---

29 The structures of two 3º-bicyclic chlorides (**I** and **II**) are shown below.



I **II**

Which of the following statements is correct?

○ A) on treatment with KOH in ethanol, both compounds undergo E2 elimination.
○ B) on treatment with KOH in ethanol, **I** undergoes substitution and **II** undergoes eleimination.
○ C) **I** is more reactive than **II** for both substitution and eleimination
○ D) **II** is more reactive than **I** for both substitution and eleimination

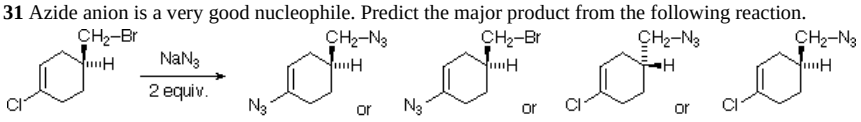
---

30 Reaction of (R)-2-chloro-4-methylpentane with excess NaI in acetone gives racemic 2-iodo-4-methylpentane
How can this be explained?

○ A) the reaction mechanism changes to S_N1
○ B) the reaction proceeds via a rapidly inverting radical intermediate
○ C) the substitution is S_N2, but repeated attack by iodide anion (with inversion) leads to racemization
○ D) iodide anion preferentially attacks chlorine, giving a rapidly inverting carbanion intermediate

---

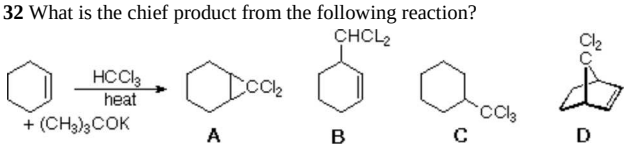
31 Azide anion is a very good nucleophile. Predict the major product from the following reaction.



A **B** **C** **D**

---

32 What is the chief product from the following reaction?



A **B** **C** **D**

---

33 Consider the S_N1 solvolysis of the following 1º-alkyl chlorides in aqueous ethanol.
I $CH_3CH_2CH_2Cl$ **II** $CH_2{=}CHCH_2Cl$ **III** CH_3OCH_2Cl **IV** $CF_3CF_2CH_2Cl$
What is the order of decreasing reactivity?

○ A) III > II > I > IV
○ B) II > I > III > IV
○ C) IV > III > II > I
○ D) I > II > III > IV

---

34 In the S_N2 reaction of iodide ion with $(CH_3)_2CHCH_2CH_2X$ what is the order of decreasing reactivity for the following X substituents?
I X = -OH **II** X = CH_3CO_2- **III** X = CF_3SO_3- **IV** X = CCl_3CO_2-

○ A) I > II > III > IV
○ B) IV > III > II > I
○ C) III > II > IV > I
○ D) III > IV > II > I

---

35 A $C_6H_{14}O$ chiral alcohol is converted to a bromide by treatment with PBr_3.
Reaction of this bromide, first with Mg in ether, followed by quenching in 0.1 N HCl produces an achiral C_6H_{14} hydrocarbon.
Which of the following is the original alcohol.?

○ A) 2-ethyl-1-butanol.
○ B) 4-methyl-1-pentanol.
○ C) 3-methyl-3-pentanol.
○ D) 3-methyl-1-pentanol.

---

36 Which of the following reaction sequences would best serve to convert 2-methyl-1-bromopropane to 4-methyl-1-iodopentane?

○ A) **(i)** Mg in ether; .**(ii)** ethylene oxide (C_2H_4O); **(iii)** HI & heat
○ B) **(i)** NaC≡CH in ether; .**(ii)** H_2 + Lindlar catalyst; **(iii)** HI
○ C) **(i)** KOH in alcohol; . **(ii)** $C_6H_5CO_3H$ in CH_2Cl_2; **(iii)** NaC≡CH in ether ; **(iv)** 2 H_2 + Pt catalyst
○ D) **(i)** NaC≡CH in ether; .**(ii)** H_3O^+ + $HgSO_4$; **(iii)** HI & heat

---

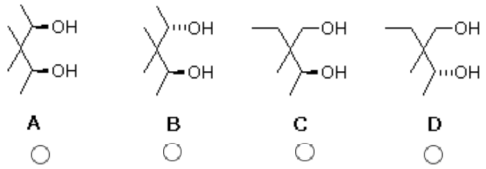
37 Which of the following organic halides will undergo an E2 elimination on heating with KOH in alcohol?

○ A) 2,2-dimethyl-1-bromopropane
○ B) 2,2-dimethyl-1-bromocyclohexane

○ C) benzyl chloride ($C_6H_5CH_2Cl$)
○ D) 2,5-dimethyl-1-bromobenzene

---

38 A chiral $C_7H_{16}O_2$ diol is oxidized by PCC in CH_2Cl_2 to an achiral $C_7H_{12}O_2$ compound.
Which of the following would satisfy these facts?



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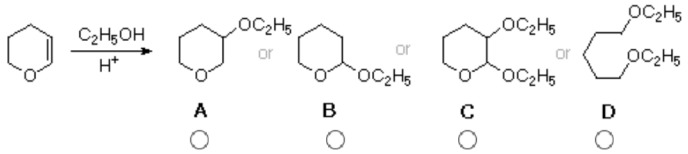
39 What is the product from the acid catalyzed addition of methanol to 2,2-diethyloxirane?
○ A) 3,3-dimethoxypentane
○ B) 2-ethyl-1-methoxy-1-butanol
○ C) 2-ethyl-1-methoxy-2-butanol
○ D) 2-ethyl-2-methoxy-1-butanol

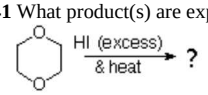
---

40 Which of the following is the product from ethanol addition to dihydropyran (shown on the left below)?



---

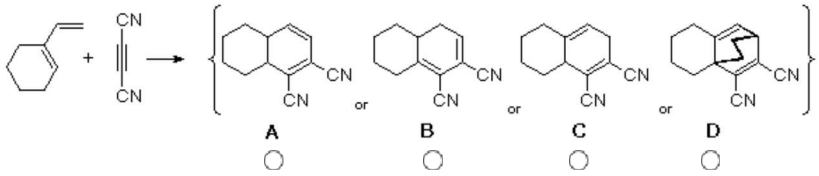
41 What product(s) are expected from the following reaction?



○ A) 2 CH_3CH_2I
○ B) 2 ICH_2CH_2OH
○ C) 2 ICH_2CH_2I
○ D) CH_3CH_2I + CH_3CH_2OH

---

42 Which of the following is the most likely product of this Diels-Alder reaction?



---

43 Reaction of 1,1-dibromopentane with three equivalents of $NaNH_2$ in ether is followed by treatment with 0.1M HCl at 0° C.
What is the product?
○ A) cyclopentene.
○ B) 1,2-pentadiene.
○ C) 2-pentyne.
○ D) 1-pentyne.

---

44 Which of the following reagents and conditions would best serve to convert 1-butyne to 1-bromo-1-butene?
○ A) 1 equivalent of HBr, no peroxides.
○ B) 1 equivalent of HBr, with peroxides.
○ C) 1 equivalent of Br_2, followed by 1 equivalent of KOH.
○ D) 2 equivalents of HBr, followed by 1 equivalent of KOH.

---

45 Which of the following reagents would be best for oxidizing a 1°-alcohol to an aldehyde?
○ A) H_3PO_4
○ B) PCC in CH_2Cl_2
○ C) Jones' reagent (H_2CrO_4)
○ D) OsO_4

---

46 If the rate of reaction of [0.1 M] sodium cyanide with [0.1M] 1-bromoethane is 1.4×10^{-4},
what effect will an increase in NaCN concentration to [0.3] and alkyl bromide concentration to [0.2] have on the overall reaction rate?
○ A) increase by 2 times
○ B) increase by 3 times
○ C) iincrease by 6 times

○ D) increase by 1.5 times

---

47 A chiral $C_5H_{10}O$ alcohol is reduced by catalytic hydrogenation to an achiral $C_5H_{12}O$ alcohol.
The original alcohol is oxidized by activated MnO_2 to an achiral carbonyl compound (C_5H_8O)
Which of the following might be the chiral alcohol?

○ A) 1-penten-3-ol
○ B) 4-penten-2-ol
○ C) 3-methyl-2-buten-1-ol
○ D) 2-methyl-2-buten-1-ol

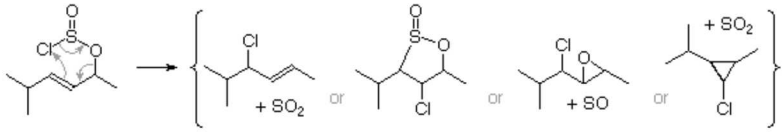
---

48 A water soluble $C_6H_{14}O_2$ compound is oxidized by lead tetraacetate (or periodic acid) to a single C_3H_6O carbonyl compound.
Which of the following would satisfy this fact?

○ A) meso-2,3-dimethoxybutane
○ B) 1,2-diethoxyethane
○ C) meso-2,5-hexanediol
○ D) meso-3,4-hexanediol

---

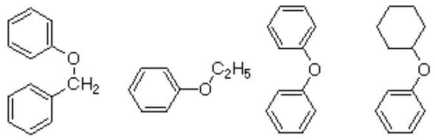
49 Which of the following is the most likely product from the reaction illustrated by the curved arrows in the formula on the left?



A ○ B ○ C ○ D ○

---

50 Which of the following ethers is unlikely to be cleaved by hot conc. HBr?



A ○ B ○ C ○ D ○

---

51 What reagents and conditions are used for the Simmons-Smith reaction?

○ A) CH_3I + Mg in ether
○ B) CH_2I_2 + Zn (Cu) in ether
○ C) $BrCH_2CH_2Br$ + Zn in ether
○ D) CBr_4 + Zn (Cu) in ether

---

52 The Lucas test is used to distinguish small (7 or fewer carbons) 1º, 2º and 3º -alcohols.
The alcohol to be tested is added to a solution of anhydrous $ZnCl_2$ in conc. HCl at room temperature.
Which of the following statements **is not** correct?

○ A) 1º-alcohols dissolve, but do not react
○ B) 3º-alcohols react quickly to give an insoluble alkyl chloride
○ C) 3º-alcohols rapidly dehydrate, and the gaseous alkene bubbles out of the test solution
○ D) 2º-alcohols dissolve and react slowly to give an insoluble alkyl chloride

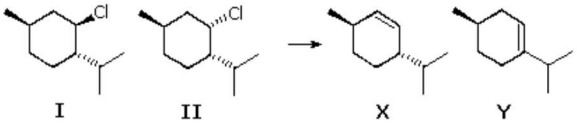
---

53 A $C_6H_{12}O$ compound does not react with Br_2 in CCl_4, produces a flammable gas on treatment with $LiAlH_4$, and reacts with H_2CrO_4 changing the color from orange to green
Which of the following compounds best agrees with these facts?

○ A) 1-methylcyclopentanol
○ B) methoxycyclopentane
○ C) 2-cyclopropyl-2-propanol
○ D) 2-cyclobutylethanol

---

54 Stereoisomers **I** and **II** undergo E2 elimination on treatment with sodium ethoxide in ethanol.
One isomer reacts 500 times faster than the other. Also, one isomer gives **X** as the only product, whereas the other gives **Y** together with some **X**
Which of the following statements provides the best assignment of **I** and **II**?



I II X Y

○ A) **II** reacts faster and gives both **Y** & **X**
○ B) **II** reacts faster and gives only **X**
○ C) **I** reacts faster and gives both **Y** & **X**
○ D) **I** reacts faster and gives only **X**

Check Answers

Reset/Clear

View Answers

Stereochemistry

Note, the term stereogenic center is used analogously to chiral center.

---

1. The spatial orientation of the atoms of a molecule is called its what?
○ A) constitution ○ B) configuration ○ C) handedness ○ D) composition

2. An object that has no element of symmetry is called what?
○ A) tetrahedral ○ B) achiral ○ C) symmetric ○ D) asymmetric

---

3 Stereoisomers differ from each other in what respect?
○ A) composition.
○ B) constitution
○ C) configuration
○ D) steric hindrance

---

4 Which of the following must be true for an optically active compound?
○ A) the molecular configuration is achiral
○ B) the molecular configuration is chiral
○ C) the compound is a racemic mixture of enantiomers
○ D) the molecular configuration must have two or more stereogenic centers

---

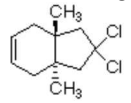
5 Enantiomers are?
○ A) stereoisomers having non-identical mirror image configurations
○ B) stereoisomers that do not have non-identical mirror image configurations
○ C) stereoisomers having a mirror plane of symmetry
○ D) achiral stereoisomers

---

6 Which conformation of cyclohexane has a C_3 axis of symmetry?
○ A) boat
○ B) twist boat
○ C) chair
○ D) envelope

---

7 The following compound has how many stereogenic centers?

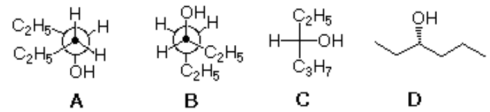


○ A) 0
○ B) 1
○ C) 2
○ D) 3

8 Hydration, by oxymercuation, of 3-methyl-1-butene gives 3-methyl-2-butanol.
What is the observed rotation of this product, using a 20% solution in ethanol in a 1dm polarimeter cell?.
Assume the specific roatation of the pure (S)-enantiomer to be +16º
○ A) +3.2º
○ B) -3.2º
○ C) 180º (+ or -)
○ D) 0º

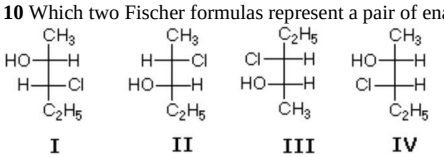
---

9 Which of the following is (R)-3-hexanol?



○ ○ ○ ○

10 Which two Fischer formulas represent a pair of enantiomers?



○ A) I & II
○ B) III & IV

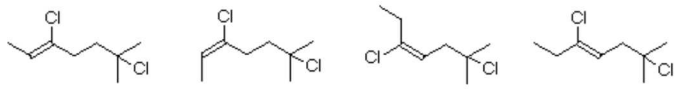
○ C) I & IV
○ D) II & III

---

11 Consider the Fischer projection formula for (S)-2-chlorobutane
Which of the following changes **does not** convert this structure to the (R)-enantiomer?
○ A) rotation 180º in the plane of the paper (or screen)
○ B) flipping the structure over (a 180º rotation out of the plane)
○ C) exchanging the two vertical substituents (i.e. top and bottom)
○ D) exchanging the two horizontal substituents (i.e. right and left)

---

12 Which of the following represents (E)-3,6-dichloro-6-methyl-3-heptene?



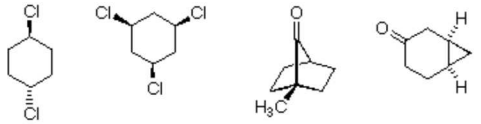
A ○ B ○ C ○ D ○

---

13 Designate the CIP priority order of the following C_5H_{11}- groups. (Lowest < Highest priority order)
I $CH_3(CH_2)_4-$ **II** $(CH_3)_3CCH_2-$ **III** $C_3H_7CH(CH_3)-$ **IV** $(CH_3)_2CHCH_2CH_2-$
○ A) I < II < III < IV
○ B) IV < III < II < I
○ C) I < IV < II < III
○ D) III < II < IV < I

---

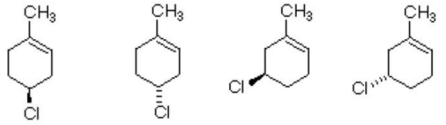
14 Which of the following compounds has two stereogenic centers (asymmetric carbons)?



A ○ B ○ C ○ D ○

---

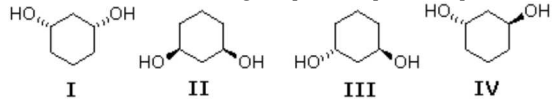
15 Which of the following compounds is (S)-4-chloro-1-methylcyclohexene?



A ○ B ○ C ○ D ○

---

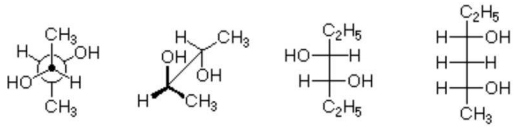
16 Which two of the following compounds represents a pair of enantiomers?



○ A) I & II
○ B) II & III
○ C) III & IV
○ D) II & IV

---

17 Which of the following is properly classified as a **meso** compound?



A ○ B ○ C ○ D ○

---

18 When HOBr adds to 4-methylcyclopentene, how many new stereogenic centers are formed?
○ A) 1
○ B) 2
○ C) 3
○ D) 4

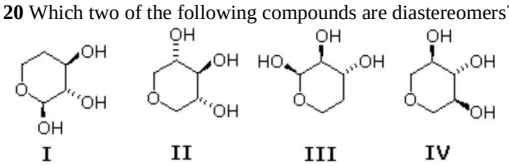
---

19 Which of the following isomeric dienes is chiral?

- A) 2,3-pentadiene
- B) 3-methyl-1,2-butadiene
- C) 2-methyl-1,3-butadiene
- D) none, all are achiral

---

20 Which two of the following compounds are diastereomers?



I II III IV

- I & II
- II & IV
- III & IV
- I & III

21 Two equivalents of bromine add to one equivalent of 1,7-octadiene.
How many stereoisomeric tetrabromides will be formed?

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

---

22 Two equivalents of OsO_4 hydroxylate one equivalent of 1,5-cyclooctadiene.
How many stereoisomeric cyclooctane-1,2,5,6-tetraols will be formed?

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

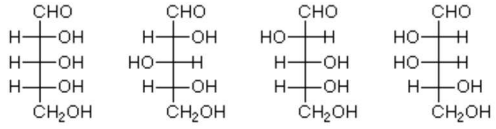
---

23 The optically active bromohydrin (1R, 2R)-2-bromocyclohexanol reacts with base to produce cyclohexene oxide ($C_6H_{10}O$).
Which of the following statements is true?

- A) a racemic product is formed
- B) the observed optical rotation changes sign
- C) the observed optical rotation does not change sign
- D) the product is achiral

---

24 Which of the following sugars has the configuration (**2S, 3R, 4R**)?

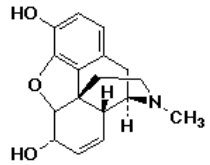


A B C D

---

25 How many stereogenic carbon centers are there in morphine, structure shown below?

- A) 4
- B) 5
- C) 6
- D) 7



---

26 Pure (S)-2-butanol has a specific rotation of +13.52 degrees.
You have made and purified a sample that has a calculated specific rotation of +6.76 degrees.
What can you conclude about this sample?

- A) the sample has completely racemized
- B) 50% the sample has rearranged into a meso isomer
- C) 50% of the sample has racemized
- D) 75% of the sample has racemized

---

27 How many stereoisomers of $(CH_3)_2CHCH{=}CHCH_2CH(OH)CH_2Br$ are possible?

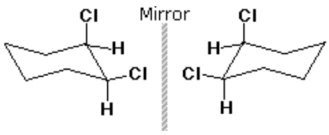
- A) 2
- B) 3
- C) 4
- D) 5

28 If two isomers have been classified correctly as **epimers**, they may also be called...?

- A) diastereomers
- B) enantiomers
- C) tautomers
- D) conformers

29

The drawing on the right shows that *cis*-1,2-dichlorocyclohexane is chiral. Efforts to resolve this compound fail. Why?

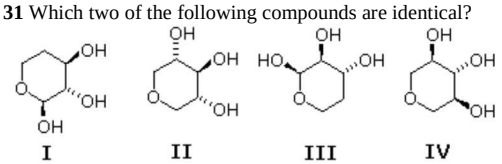


- A) the cis and trans isomers rapidly interconvert.
- B) the compound is actually a meso structure.
- C) the chair conformers rapidly interconvert producing a racemic mixture.
- D) methods for resolving alkyl chlorides are not available.

30 Which of the following statements **must be true** for two pure chiral isomers ?

- A) they must be enantiomers
- B) they must be diastereomers
- C) they must be stereoisomers
- D) they must be optically active

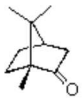
31 Which two of the following compounds are identical?



- A) I & II
- B) II & IV
- C) III & IV
- D) I & III

32

The structural formula on the right is that of camphor. Which of the following statements is correct?



- A) This compound has two stereogenic centers and exists as a pair of enantiomers.
- B) This compound is achiral.
- C) This compound has three stereogenic centers and exists as a pair of enantiomers and a meso isomer.
- D) This compound does not have an enantiomer

33 Which of the following statements is true for a pair of diastereomers?

- A) they will have identical physiological properties.
- B) they will have specific rotations of opposite sign.
- C) they will have identical chemical properties (e.g. reactivity)
- D) they will have different physical properties.

34 Which of the following descriptive terms **would never** be applied to a pair of stereoisomers ?

- A) enantiomers
- B) tautomers
- C) diastereomers
- D) epimers

35 What kind of reagent would be needed to resolve a racemic amine, such as 2-aminobutane ?

- A) the pure optically active amine to serve as a template for crystallization.
- B) an achiral carboxylic acid to give a racemic mixture of amine salts.
- C) an enantiomerically pure chiral carboxylic acid to give a diastereomeric mixture of amine salts.
- D) a racemic chiral carboxylic acid to give a complete mixture of isomeric amine salts.

36 What common symmetry elements if any are found in the stable chair conformer of *trans*-1,4-dichlorocyclohexane?

- A) a single mirror plane and a C_2 rotational axis.
- B) a C_3 rotational axis but no mirror plane.
- C) two orthogonal mirror planes and a C_2 rotational axis.
- D) a single C_2 rotational axis but no mirror plane.

37 What common symmetry elements if any are found in the stable chair conformer of *trans*-1,2-dichlorocyclohexane?

- A) a single mirror plane and a C_2 rotational axis.
- B) a single mirror plane and a C_3 rotational axis.
- C) two orthogonal mirror planes and a C_2 rotational axis.
- D) a single C_2 rotational axis but no mirror plane.

---

38 Reaction of 3-methyl-1,4-cycloheptadiene with excess perbenzoic acid ($C_6H_5CO_3H$) forms a diepoxide product.
How many stereoisomers, counting enantiomers, are expected from this reaction ?

- A) 4 (two pairs of enantiomers)
- B) 4 (two meso compounds and a pair of enantiomers)
- C) 5 (two pairs of enantiomers and a meso compound)
- D) 6 (two pairs of enantiomers and two meso compounds)

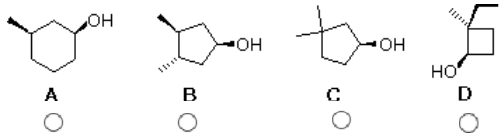
---

39 The antimalarial alkaloid quinine, $C_{20}H_{24}N_2O_2$, is optically active.
An ethanol solution of 8g quinine in 100mL displays a rotation of -13.6º in a 1dm polarimeter tube.
What is the specific rotation of quinine?

- A) -85º
- B) -170º
- C) -43º
- D) -26º

---

40 A $C_7H_{14}O$ optically active alcohol is oxidized by Jones' reagent to an optically inactive (achiral) ketone.
Which of the following compounds meets these facts?



A B C D

---

41 Which of the following compounds has a prochiral methylene group (i.e. the hydrogen atoms are diastereotopic)?

- A) propane , $CH_3CH_2CH_3$
- B) cyclopropane , $(CH_2)_3$
- C) 2-methylpropene , $CH_2=C(CH_3)_2$
- D) ethanol , CH_3CH_2OH

---

42 The thermal electrocyclic closure of (2E,4Z,6E)-2,4,6-octatriene gives which of the following?

- A) *cis*-5,6-dimethyl-1,3-cyclohexadiene
- B) *trans*-5,6-dimethyl-1,3-cyclohexadiene
- C) *cis*-3,6-dimethyl-1,4-cyclohexadiene
- D) *cis*-3,6-dimethyl-1,4-cyclohexadiene

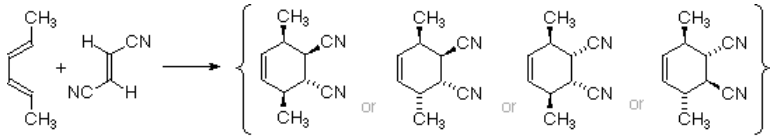
---

43 The Cope rearrangement, [3,3]-sigmatropic shift, of *meso*-3,4-dimethyl-1,5-hexadiene gives which of the following?

- A) 1,7-octadiene
- B) (2Z,6Z)-2,6-octadiene
- C) (2E,6Z)-2,6-octadiene
- D) (2E,6E)-2,6-octadiene

---

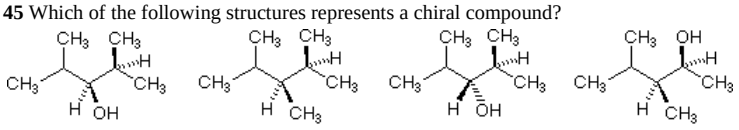
44 Which is the expected product from the following Diels-Alder reaction?



A B C D

---

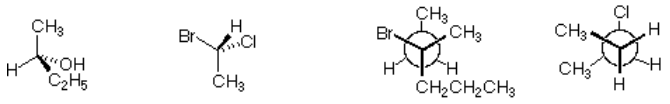
45 Which of the following structures represents a chiral compound?



A B C D

---

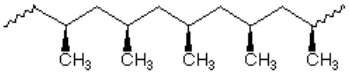
46 Which of the following compounds has a S configuration?



A ○ B ○ C ○ D ○

---

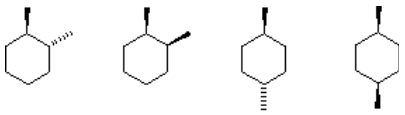
47 How should the following structure of polypropylene be classified?



- ○ A) isotactic
- ○ B) syndiotactic
- ○ C) atactic
- ○ D) head-to-head

---

48 Which of the following C_8H_{16} isomers is thermodynamically most stable?



A ○ B ○ C ○ D ○

---

49 Which of the following statements **is not** an essential feature of an optically active compound?

- ○ A) the molecules of an optically active compound will be dissymetric or asymmetric.
- ○ B) the molecules of an optically active molecule must have at least one stereogenic site.
- ○ C) an optically active compound's molecular configuration will not be identical with its mirror image.
- ○ D) an optically active compound will have at least one stereoisomer.

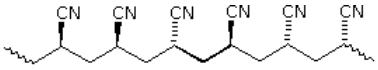
---

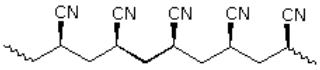
50 Which of the following statements **is not** correct?

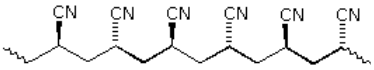
- ○ A) a pair of enantiomeric compounds will have the same melting point.
- ○ B) a pair of enantiomeric compounds will have the same solubility in ethanol.
- ○ C) a pair of enantiomeric compounds will have exactly the same functional groups.
- ○ D) a pair of enantiomeric compounds will have identical optical rotations.

---

51 Which of the structures on the right, if any, represents syndiotactic polyacrylonitrile?

○ A 

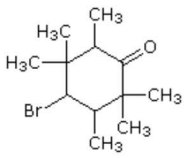
○ B 

○ C 

○ D None of these structures

---

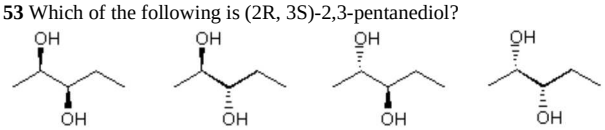
52 Examine the compound on the right.
How many stereoisomers having this constitution are possible?



A 2 ○ **B** 4 ○ **C** 6 ○ **D** 8 ○

---

53 Which of the following is (2R, 3S)-2,3-pentanediol?

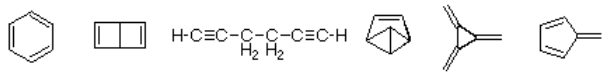


A ○ B ○ C ○ D ○

Check Answers | Reset/Clear | View Answers

Structure and Reactivity of Aromatic Compounds

1. Which of the following C_6H_6 compounds has a single set of structurally equivalent hydrogen atoms?

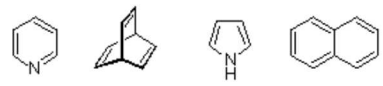


I II III IV V VI

- A) I & II
- B) I, IV & VI
- C) I & V
- D) I, II & III

---

2. Which of the following compounds would be **not** be considered **aromatic** in its behavior?



A B C D

---

3 How many isomeric tribromobenzenes exist?

- A) none! (such a compound cannot exist)
- B) 1
- C) 2
- D) 3

---

4 A C_8H_{10} hydrocarbon is nitrated by HNO_3 and sulfuric acid.
Two, and only two, $C_8H_9NO_2$ isomers are obtained.
Which of the following fits this evidence?

- A) ethylbenzene
- B) *ortho*-xylene
- C) *meta*-xylene
- D) *para*-xylene

---

5 Which of the following is an important reactive electrophile in aromatic ring nitration?

- A) $NO_2^{(+)}$
- B) $NO^{(+)}$
- C) $N_2^{(+)}$
- D) $N_2O^{(+)}$

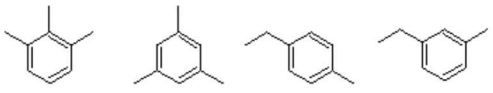
---

6 Bromination of *meta*-chloronitrobenzene may produce how many $C_6H_3ClBrNO_2$ isomers?

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

---

7 What C_9H_{12} hydrocarbon would give a single $C_9H_{11}SO_3H$ product on sulfonation?



A B C D

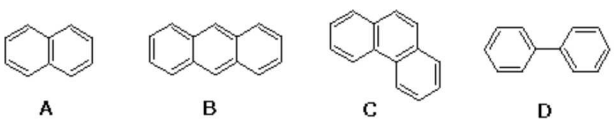
---

8 How many isomeric dinitrobenzoic acids can exist? $C_6H_3(NO_2)_2CO_2H$

- A) 3
- B) 4
- C) 5
- D) 6

---

9 Which of the following compounds is phenanthrene?



A B C D

---

10 Which of the following is phenol?

- A) C_6H_5OH
- B) $C_6H_5CH_2OH$
- C) $C_6H_5COCH_3$
- D) $C_6H_5OCH_3$

---

11 What is the order of reactivity of the following compounds in electrophilic substitution? (more reactive > less reactive)

I toluene **II** nitrobenzene **III** benzene **IV** phenol

- A) I > II > III > IV
- B) IV > III > II > I
- C) I > III > IV > II
- D) IV > I > III > II

---

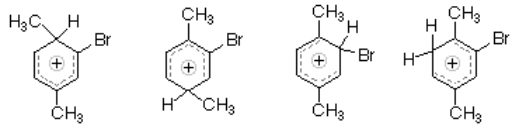
12 What is the order of reactivity of the following compounds in electrophilic substitution? (more reactive > less reactive)

I chlorobenzene **II** aniline **III** ethylbenzene **IV** benzoic acid

- A) I > II > III > IV
- B) II > III > I > IV
- C) I > III > IV > II
- D) II > I > IV > III

---

13 Which of the following structures most closely represents an intermediate in the electrophilic bromination of *para*-xylene?



A ○ B ○ C ○ D ○

---

14 What is the order of increased meta electrophilic substitution for the following compounds? (more meta product > less meta product)

I $C_6H_5N(CH_3)_3^{(+)}$ **II** $C_6H_5CH_2Cl$ **III** $C_6H_5CHCl_2$ **IV** $C_6H_5CCl_3$

- A) I > II > III > IV
- B) III > II > IV > I
- C) I > II > IV > III
- D) I > IV > III > II

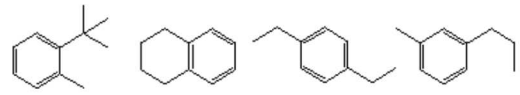
---

15 Which of the following benzene ring substituents is deactivating but ortho-para directing?

- A) -N=O
- B) $-OCH_3$
- C) $-COCH_3$
- D) $-NO_2$

---

16 Which of the following compounds forms *ortho*-benzenedicarboxylic acid when oxidized by hot aqueous potassium permanganate?



A ○ B ○ C ○ D ○

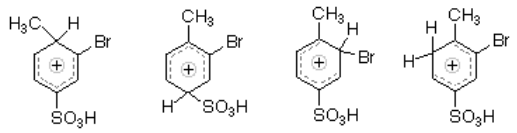
---

17 Which of the following organic chlorides will not give a Friedel-Craft alkylation product when heated with benzene and $AlCl_3$.

- A) $(CH_3)_3CCl$
- B) $CH_2=CHCH_2Cl$
- C) CH_3CH_2Cl
- D) $CH_2=CHCl$

---

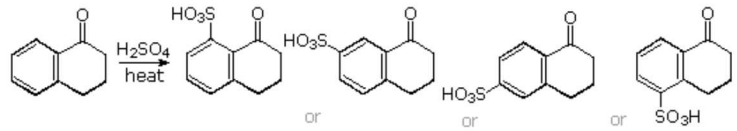
18 Electrophilic bromination of *para*-toluenesulfonic acid, folowed by heating with 50% sulfuric acid produces *ortho*-bromotoluene. Which of the following intermediates leads to this product?



A ○ B ○ C ○ D ○

---

19 Which of the following is the major product from sulfonation of α-tetralone?



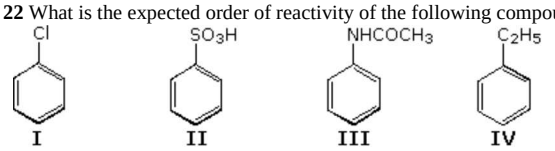
20 Which of the following substituents on a benzene ring is ortho-para directing?

- A) $-OCOCH_3$
- B) $-COCH_3$
- C) $-CO_2H$
- D) -CN

21 Which of the following compounds reacts rapidly with Br_2 in the dark?

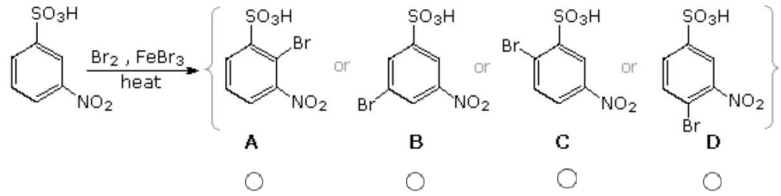
- A) benzene
- B) anisole $C_6H_5OCH_3$
- C) acetophenone $C_6H_5COCH_3$
- D) none of the above

22 What is the expected order of reactivity of the following compounds in electrophilic nitration? (more reactive > less reactive)

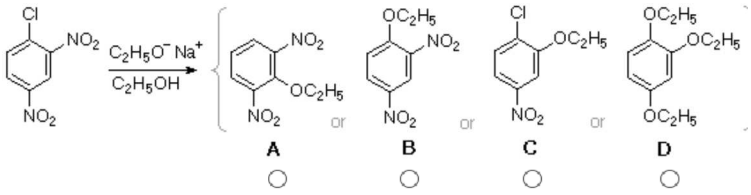


- A) I > II > III > IV
- B) IV > III > II > I
- C) III > IV > I > II
- D) II > I > IV > III

23 Which of the following is the major product from bromination of *meta*-nitrobenzenesulfonic acid?



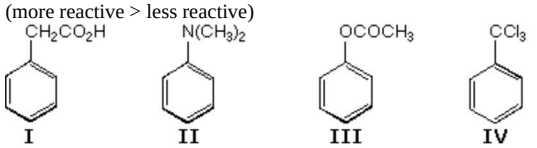
24 Which of the following is the major product from this reaction?



25 Which of the following reaction sequences would be best for converting *para*-bromoanisole to *ortho*-ethylanisole?

- A) **(i)** H_2 & Pt catalyst **(ii)** C_2H_5Cl & $AlCl_3$
- B) **(i)** Mg in ether **(ii)** aqueous alcohol **(iii)** C_2H_5Cl & $AlCl_3$
- C) **(i)** Mg in ether **(ii)** C_2H_5Cl & $AlCl_3$
- D) **(i)** C_2H_5Cl & $AlCl_3$ **(ii)** Mg in ether **(iii)** aqueous alcohol

26 What is the expected order of reactivity of the following compounds in electrophilic chlorination (Cl_2 + $FeCl_3$)?
(more reactive > less reactive)



- A) I > II > III > IV
- B) IV > III > II > I
- C) III > I > IV > II
- D) II > III > I > IV

27 When Friedel-Craft alkylation of benzene is carried out with 1 equiv. of *tert*-butyl chloride, a large amount of *para*-di-*tert*-butylbenzene is formed, along with the mono-substitution product.
Why doesn't all the benzene react to give *tert*-butylbenzene (the mono-substitution product)?

- A) the *tert*-butyl substituent activates the benzene ring to further substitution.
- B) the reaction is bimolecular, so two *tert*-butyl chloride molecules combine with one benzene molecule.
- C) the *tert*-butyl substituent is large and favors reaction at the para-position.
- D) the disubstituted product is favored in equilibrium with the mono-substituted ring..

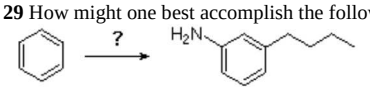
---

28 When *para*-bromotoluene is treated with $NaNH_2$ in ether, the bromine is lost and a mixture of *para* & *meta*-$CH_3C_6H_4NH_2$ products is obtained.
What kind of intermediate would account for this?

- A) a charge delocalized anion formed by nucleophilic addition of $NH_2^{(-)}$ to the benzene ring..
- B) a charge delocalized anion formed by abstraction of a methyl proton by the base $NH_2^{(-)}$.
- C) an aryl cation formed by loss of bromide anion.
- D) a benzyne species formed by elimination of HBr.

---

29 How might one best accomplish the following synthesis?



- A) **(i)** $C_4H_9Cl + AlCl_3$ **(ii)** HNO_3 & heat **(iii)** excess H_2 & Pt catalyst
- B) **(i)** HNO_3 & heat **(ii)** $C_4H_9Cl + AlCl_3$ **(iii)** excess H_2 & Pt catalyst
- C) **(i)** $C_3H_7COCl + AlCl_3$ **(ii)** HNO_3 & heat **(iii)** excess H_2 & Pt catalyst
- D) **(i)** HNO_3 & heat **(ii)** $C_3H_7COCl + AlCl_3$ **(iii)** excess H_2 & Pt catalyst

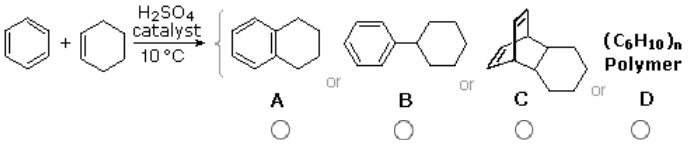
---

30 Sulfonation of naphthalene by conc. sulfuric acid produces the 1-sulfonic acid at 120 ºC and the 2-sulfonic acid at 160 ºC.
Which of the following statements is **not true**?

- A) the 2- sulfonic acid is kinetically favored
- B) sulfonation is a reversible reaction
- C) the 2- sulfonic acid is thermodynamically favored (more stable)
- D) electrophilic attack at C-1 is favored over attack at C-2

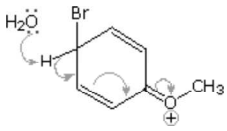
---

31 Which of the following is the likely outcome from this reaction?



32

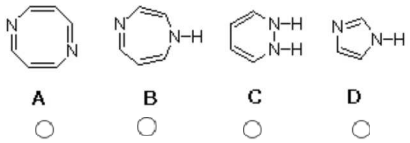
The mechanism on the right illustrates the breakdown of an intermediate.
Which of the following statements about this mechanism is **correct**?



- A) the organic product is anisole (methoxybenzene).
- B) the organic product is bromobenzene.
- C) HBr is released in the reaction.
- D) water functions as a base.

---

33 Which of the following heterocyclic compounds would have **aromatic** character?



---

34 $C_6H_5OCH_2CH_2Br$ is heated with Mg in ether and then quenched in cold 10% HCl.
What organic product will be obtained by ether extraction of the aqueous acid?

- A) $C_6H_5OCH_2CH_3$
- B) $C_6H_5OCH_2CH_2OH$
- C) C_6H_5OH
- D) C_6H_6

---

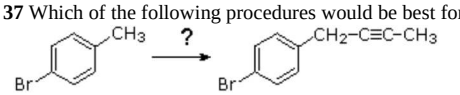
35 A $C_9H_{12}O$ compound is reacted with a solution of lithium in liquid ammonia.
After evaporation of the ammonia, the residue is warmed with 10% HCl and extracted with ether.
The product is identified as 2-cyclohexenone. Which of the following might be the starting compound?

- A) $C_6H_5OC_3H_7$
- B) $C_6H_5CH_2CH_2CH_2OH$
- C) $C_6H_5CH_2CH_2OCH_3$
- D) $C_6H_5CH_2CH(OH)CH_3$

36 Which of the following procedures would be best for the preparation of phenyl benzyl ether? $C_6H_5OCH_2C_6H_5$

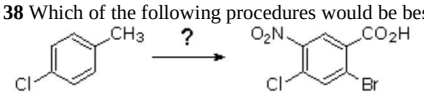
- A) $C_6H_5Cl + C_6H_5CH_2O^{(-)}\ Na^{(+)}$
- B) $C_6H_5O^{(-)}\ Na^{(+)} + C_6H_5CH_2Cl$
- C) $2\ C_6H_5Cl + Na_2O$
- D) $2\ C_6H_5MgBr + CH_2O$

37 Which of the following procedures would be best for achieving the following reaction?



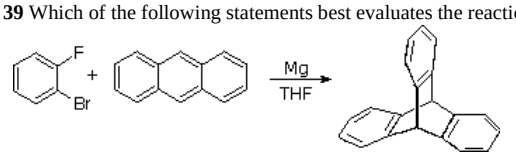
- A) **(i)** KOH & heat **(ii)** $CH_3C{\equiv}C$-Br
- B) **(i)** $KMnO_4$ & heat **(ii)** $CH_3C{\equiv}C^{(-)}\ Na^{(+)}$ **(iii)** excess H_2O
- C) **(i)** NBS in CCl_4 & heat **(ii)** $CH_3C{\equiv}C^{(-)}\ Na^{(+)}$
- D) **(i)** Mg in ether **(ii)** $CH_3C{\equiv}CBr$ **(iii)** excess H_3PO_4

38 Which of the following procedures would be best for achieving the following reaction?



- A) **(i)** $Br_2 + FeBr_3$ **(ii)** $KMnO_4$ & heat **(iii)** HNO_3 & H_4SO_4
- B) **(i)** $KMnO_4$ & heat **(ii)** $Br_2 + FeBr_3$ **(iii)** HNO_3 & H_4SO_4
- C) **(i)** NBS in CCl_4 & heat **(ii)** $KMnO_4$ & heat **(iii)** HNO_3 & H_4SO_4
- D) **(i)** NBS in CCl_4 & heat **(ii)** $NaNO_2$ **(iii)** $KMnO_4$ & heat

39 Which of the following statements best evaluates the reaction shown below?

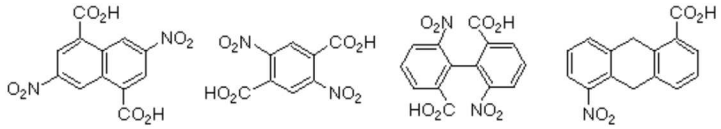


- A) a Grignard reagent from the dihalobenzene adds to anthracene, followed by nucleophilic displacement of fluoride anion to form the product..
- B) magnesium reduces anthracene to a reactive dianion that bonds to the dihalobenzene.
- C) a Grignard reagent from the dihalobenzene metalates the anthracene, and this nucleophile adds to the remaining fluorobenzene.
- D) a Grignard reagent from the dihalobenzene decomposes to benzyne, which then cycloadds to anthracene.

40 Which reaction sequence would be best for preparing 3,5-dibromoaniline from nitrobenzene?

- A) **(i)** $3\ H_2$ & Pt or Ni catalyst **(ii)** $2\ Br_2$ in ether
- B) **(i)** excess $Br_2 + FeBr_3$ & heat **(ii)** $3\ H_2$ & Pt or Ni catalyst
- C) **(i)** $3\ H_2$ & Pt or Ni catalyst **(ii)** H_2SO_4 & heat **(iii)** excess HBr
- D) **(i)** H_2SO_4 & heat **(ii)** excess $Br_2 + FeBr_3$ & heat **(iii)** $3\ H_2$ & Pt or Ni catalyst

41 Which of the following carboxylic acids could be resolved by reaction with an enantiomerically pure chiral amine?



42 How could one prepare 3,4,5-tribromoaniline from *para*-nitroaniline? note: $HNO_2 = NaNO_2 + 10\%\ H_2SO_4$

- A) **(i)** $3\ H_2$ & Pt or Ni catalyst **(ii)** $2\ Br_2$ in ether **(iii)** HNO_2 0 ºC **(iv)** H_3PO_2
- B) **(i)** $3\ H_2$ & Pt or Ni catalyst **(ii)** HNO_2 0 ºC **(iii)** excess Cu_2Br_2 + HBr
- C) **(i)** $2\ Br_2$ in ether **(ii)** $3\ H_2$ & Pt or Ni catalyst **(iii)** HNO_2 0 ºC **(iv)** H_3PO_2
- D) **(i)** $2\ Br_2$ in ether **(ii)** HNO_2 0 ºC **(iii)** Cu_2Br_2 **(iv)** $3\ H_2$ & Pt or Ni catalyst

43 How could one prepare 3,5-dibromophenol from *para*-nitroaniline? note: $HNO_2 = NaNO_2 + 10\%\ H_2SO_4$

- A) **(i)** $2\ Br_2$ in ether **(ii)** HNO_2 0 ºC **(iii)** H_3PO_2 **(iv)** $3\ H_2$ & Pt or Ni catalyst **(v)** HNO_2 0 ºC, then heat
- B) **(i)** $3\ H_2$ & Pt or Ni catalyst **(ii)** HNO_2 0 ºC **(iii)** excess Cu_2Br_2 + HBr **(iv)** KOH & heat
- C) **(i)** HNO_2 0 ºC, then heat **(ii)** $2\ Br_2$ in ether **(iii)** $3\ H_2$ & Pt or Ni catalyst **(iv)** HNO_2 0 ºC **(v)** Cu_2Br_2 + HBr
- D) **(i)** $2\ Br_2$ in ether **(ii)** HNO_2 0 ºC **(iii)** Cu_2Br_2 **(iv)** $3\ H_2$ & Pt or Ni catalyst **(v)** HNO_2 0 ºC, then heat

44 Iodination of benzene is not easily caried out. How can one prepare *para*-iodobenzoic acid from *para*-nitrotoluene?
note: $HNO_2 = NaNO_2 + 10\%\ H_2SO_4$

- A) **(i)** $Br_2 + FeBr_2$ **(ii)** Mg in ether, then CO_2 **(iii)** $3\ H_2$ & Pt or Ni catalyst **(iv)** HNO_2 0 ºC **(v)** KI solution
- B) **(i)** NBS in CCl_4 & heat **(ii)** NaI in acetone **(iii)** $3\ H_2$ & Pt or Ni catalyst **(iv)** HNO_2 0 ºC **(v)** H_3PO_2

C) **(i)** 3 H_2 & Pt or Ni catalyst **(ii)** HNO_2 0 ºC **(iii)** Cu_2Br_2 + HBr **(iv)** $KMnO_4$ & heat **(v)** KI solution

D) **(i)** $KMnO_4$ & heat **(ii)** 3 H_2 & Pt or Ni catalyst **(iii)** HNO_2 0 ºC **(iv)** KI solution

---

45 An important group of comercial dyes, known as **azo dyes**, are prepared by a diazo coupling reaction.
What functional group characterizes an azo dye?

A) –N=O

B) $–N_3$

C) –N=N–

D) $–NO_2$

---

46 Which sequence of reactions would be best for preparing *meta*-propylaniline from benzene?

A) **(i)** HNO_3 & H_2SO_4 & heat **(ii)** C_3H_7COCl + $AlCl_3$ **(iii)** 5 H_2 & Pt or Ni catalyst

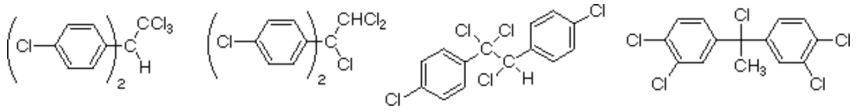
B) **(i)** C_3H_7COCl + $AlCl_3$ **(ii)** HNO_3 & H_2SO_4 & heat **(iii)** 5 H_2 & Pt or Ni catalyst

C) **(i)** C_3H_7COCl + $AlCl_3$ **(ii)** 2 H_2 & Pt or Ni catalyst **(iii)** HNO_3 & H_2SO_4 & heat **(iv)** 3 H_2 & Pt or Ni catalyst

D) **(i)** HNO_3 & H_2SO_4 & heat **(ii)** 3 H_2 & Pt or Ni catalyst **(iii)** C_3H_7COCl **(iv)** 2 H_2 & Pt or Ni catalyst

---

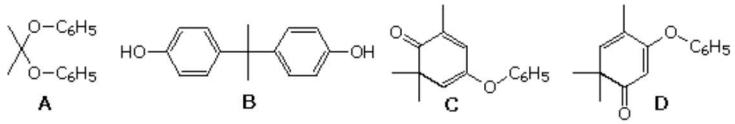
47 The insecticide DDT ($C_{14}H_9Cl_5$) is prepared by heating chlorobenzene with chloral (CCl_3CHO) in the presence of conc. sulfuric acid.
Which of the following compounds is DDT?



A B C D

---

48 Phenol reacts with acetone in the presence of conc. sulfuric acid to form a $C_{15}H_{16}O_2$ product.
Which of the following compounds is this product?



A B C D

---

49 The aromatic heterocyclic base pyridine is sulfonated by heating with conc. sulfuric acid
Which of the following statements about this reaction is correct? (note that in numbering the ring nitogen is #1)

A) pyridine reacts more rapidly than benzene and is sulfonated at C-3

B) pyridine reacts more rapidly than benzene and is sulfonated at C-2 & C-4

C) pyridine reacts more slowly than benzene and is sulfonated at C-3

D) pyridine reacts more slowly than benzene and is sulfonated at C-2 & C-4

---

50 Heating benzene in a large excess of 80% D_2SO_4 in D_2O results in what product?

A) $C_6H_5SO_3D$

B) C_6H_5OD

C) C_6H_5D

D) C_6D_6

---

51 A solution of cyclohexene in benzene is stirred at 0 ºC while concentrated sulfuric acid is added.
After washing away the acid and removing the excess benzene, what product is isolated?

A) cyclohexylbenzene

B) 1-cyclohexylcyclohexene

C) trans-1,2-diphenylcyclohexane

D) 1,1-diphenylcyclohexane

---

52 Devise a series of reactions to convert benzene into *meta*-chlorobromobenzene.
Select reagents and conditions from the following table, listing them in the order of use.

1 sulfuric acid (conc.) heat	**2** Cl_2 + $FeCl_3$ & heat	**3** $NaNO_2$ + $H_3O^{(+)}$ 0 ºC	**4** H_2 Pt catalyst	**5** Mg in ether
6 PBr_3	**7** H_3PO_2	**8** HNO_3 (conc.) + H_2SO_4 (conc.) & heat	**9** Cu_2Br_2 + HBr	**10** $(CH_3CO)_2O$ + pyridine

A) **1** then **2** then **6**

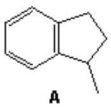
B) **2** then **8** then **4** then **3** then **9**

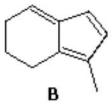
C) **8** then **4** then **10** then **2** then **3** then **9**

D) **8** then **2** then **4** then **3** then **9**

---

53 Which of the following isomeric hydrocarbons is most acidic?


A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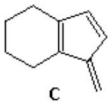
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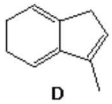

D

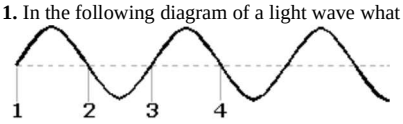
Check Answers

Reset/Clear

View Answers

Spectroscopy

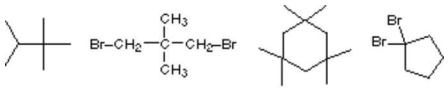
1. In the following diagram of a light wave what distance is defined as the wavelength?



- A) 1 to 2
- B) 1 to 3
- C) 1 to 4
- D) none of the above

---

2. Which of the following compounds has three different sets of structurally equivalent hydrogen atoms ?



A B C D

---

3 Four major spectroscopic tools are listed below. Which makes use of the longest wavelength radiation?

- A) infrared
- B) ultraviolet
- C) visible
- D) proton nmr

---

4 You have three dyes. One is green, one is blue and one is yellow
Which absorbs the shortest wavelength of visible light, and which absorbs the longest?

- A) longest = yellow; shortest = blue
- B) longest = blue; shortest = green
- C) longest = yellow; shortest = green
- D) longest = green; shortest = yellow

---

5 Of the following general statements concerning vibrational frequencies and intensities, which is **incorrect**.?

- A) stretching vibrations have a higher frequency than equivalent bending vibrations.
- B) stretching vibrations of double bonds have a higher frequency than those of equivalent single bonds.
- C) the stretching vibration of a Y-Y bond is more intense than that of a Y-Z bond. (Y and Z are different atoms)
- D) stretching vibrations of a Y-H bond have a higher frequency than those of a Y-Z bond. (Y and Z are heavier atoms than H)

---

6 Which if any of the following compounds will display spin-spin splitting in the ^{1}Hnmr?

- A) $(CH_3)_3COCH_3$
- B) $Br(CH_2)_3Br$
- C) *para*-xylene, $CH_3C_6H_4CH_3$
- D) none of these

---

7 The ^{1}Hnmr of 1,1-dibromoethane consists of two well-separated signals, one large and the other small.
Which of the following descriptions is correct?

- A) the large signal is a quartet and the small signal is a doublet.
- B) the large signal is a triplet and the small signal is a singlet.
- C) the large signal is a singlet and the small signal is a triplet.
- D) the large signal is a doublet and the small signal is a quartet.

---

8 Which spectroscopic tool would be best for distinguising a sample of 1,2,2-trichloropropane from 1,1,2-trichloropropane?

- A) ^{1}Hnmr
- B) infrared spectroscopy
- C) ultraviolet-visible spectroscopy
- D) mass spectrometry

---

9 Which spectroscopic tool would be best for distinguising a sample of 1,3-cyclohexadiene from 1,4-cyclohexadiene?

- A) ^{1}Hnmr
- B) infrared spectroscopy
- C) ultraviolet-visible spectroscopy
- D) mass spectrometry

---

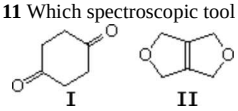
10 Which spectroscopic tool would be best for distinguising a sample of chlorocyclopentane from bromocyclopentane?

- A) ^{1}Hnmr
- B) infrared spectroscopy

C) ultraviolet-visible spectroscopy
D) mass spectrometry

---

11 Which spectroscopic tool would be best for distinguising a sample of compound I from compound II?



A) ^{1}Hnmr
B) infrared spectroscopy
C) ultraviolet-visible spectroscopy
D) mass spectrometry

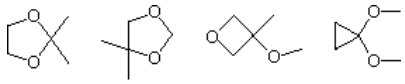
---

12 Combustion analysis of an organic compound shows it to be 64.3% carbon. It displays a molecular ion at m/z=112 amu in the mass spectrum. Which of the following ia a plausible molecular formula for this compound?

A) C_8H_{16}
B) $C_7H_{12}O$
C) $C_6H_8O_2$
D) $C_5H_4O_3$

---

13 An unknown compound has the following spectroscopic properties:
Mass Spectrometry: m/z 102 (very small), 87 & 43 are the largest ions
^{1}Hnmr: δ 1.4 & 3.9 ppm (both singlets, intensity ratio 3:2)
^{13}Cnmr: δ 108, 64 & 25 ppm,
Infrared Spectroscopy: several strong absorptions in the 1000 to 1300 cm^{-1} region
Which of the following is the most likely formula of this compound?



---

14 Which type of C–**H** has the highest stretching frequency in the infrared spectrum?

A) RC**H**O
B) RC**H**$_3$
C) R_2C=C**H**$_2$
D) RC≡C**H**

---

15 Which C=O function has the lowest stretching frequency in the infrared spectrum?

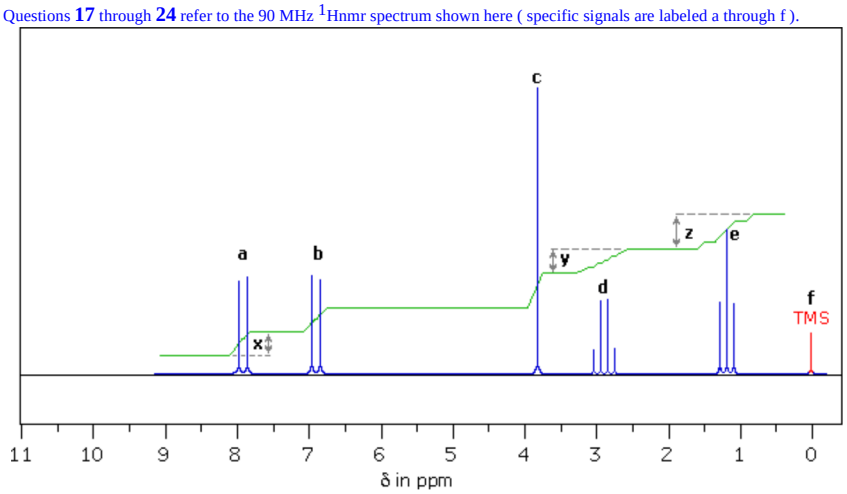
A) acyl chloride
B) aldehyde
C) amide
D) ester

---

16 Which hydrocarbon gives the lowest field ^{1}Hnmr signal?

A) cyclohexane
B) benzene
C) 1,4-cyclohexadiene
D) 1-butyne

Questions **17** through **24** refer to the 90 MHz ^{1}Hnmr spectrum shown here (specific signals are labeled a through f).



17 Of all six signal groups in this spectrum, what is the multiplicity of the lowest field signal?

- A) singlet
- B) doublet
- C) triplet
- D) quartet

---

18 Which of the six signal groups in this spectrum is located at the highest frequency?

- A) a
- B) c
- C) e
- D) f

---

19 How far from the TMS reference signal is the singlet at c (δ 3.8 ppm)?

- A) 23.7 Hz
- B) 23.7 MHz
- C) 342 Hz
- D) 342 MHz

---

20 The two sharp signals that constitute the resonance marked **a** have chemical shifts of 7.82 and 7.95
What is the coupling constant, J, for this doublet?

- A) 0.13 MHz
- B) 11.7 Hz
- C) 11.7 MHz
- D) 13 Hz

---

21 Which of the six signal groups in this spectrum is most shielded?

- A) a
- B) c
- C) e
- D) f

---

22 Ignoring the TMS reference signal what, is the mutiplicity of the highest field signal?

- A) singlet
- B) doublet
- C) triplet
- D) quartet

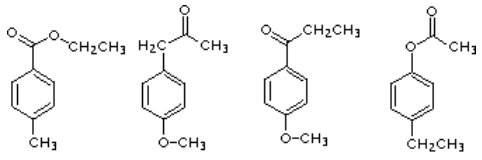
---

23 The ratio of the number of hydrogens generating doublet a to the hydrogens generating quartet d is measued how?

- A) x/y (distance in mm)
- B) 7.88/2.85 (chemical shifts in ppm)
- C) x/z (distance in mm)
- D) none of the above

---

24 If this spectrum is from a $C_{10}H_{12}O_2$ compound, having a strong absorption at 1680 cm^{-1} in the infrared, what is its likely structure?



A ○ B ○ C ○ D ○

---

25 Which statement about the nmr reference compound TMS is **not correct**?

- A) TMS stands for tetramethylsilane.
- B) all the hydrogens in TMS have the same chemical shift.
- C) TMS is relatively unreactive with most functional groups.
- D) TMS has a high boiling point, so it is not easily lost when handling the nmr sample.

---

26 A C_2H_2BrCl compound gives a ^{1}Hnmr spectrum consisting of two equal sized doublets, J=16 Hz
What is this compound?

- A) (Z)-1-bromo-2-chloroethene
- B) (E)-1-bromo-2-chloroethene
- C) 1-bromo-1-chloroethene
- D) none of the above

---

27 The ^{1}Hnmr spectrum of diethyl ether shows?

○ A) two peaks, one a triplet, the other a quartet
○ B) two peaks, one a triplet, the other a doublet
○ C) four peaks, all doublets
○ D) four peaks, all triplets

---

28 Compared with a conjugated diene, the UV-visible absorption spectrum of a conjugated triene will change in which way?
○ A) the λ_{max} will increase and the ε will decrease
○ B) the λ_{max} will decrease and the ε will increase
○ C) both the λ_{max} and the ε will decrease
○ D) both the λ_{max} and the ε will increase

---

29 The conjugated diene, 1,3-cyclohexadiene, has four π-molecular orbitals.
In order of increasing energy these are: π_1, π_2, π_3 and π_4.
Which of these is the HOMO of the electronic ground state?
○ A) π_1
○ B) π_2
○ C) π_3
○ D) π_4

---

30 The ^{1}Hnmr spectrum of a C_6H_8 hydrocarbon displays a single sharp signal. The ^{13}Cnmr spectrum has two resonance signals.
Which of the following compounds would fit this evidence?

○ ○ ○ ○

---

31 Consider four $C_3H_5Cl_3$ isomers.
Which has two ^{1}Hnmr singlets and three ^{13}Cnmr signals?
○ A) $CH_3CH_2CCl_3$
○ B) $CH_2ClCHClCH_2Cl$
○ C) $CH_3CHClCHCl_2$
○ D) $CH_3CCl_2CH_2Cl$

---

32 Consider four $C_3H_6Cl_2$ isomers. Select those compounds having two ^{13}Cnmr signals.
Which of these displays no molecular ion in the mass spectrum, but has ions at 99 & 101 m/z as well as 77 & 79 m/z (ratio of lower to higher mass is 3**:**1 in each case)?
○ A) $CH_3CCl_2CH_3$
○ B) $CH_3CH_2CHCl_2$
○ C) $CH_2ClCH_2CH_2Cl$
○ D) $CH_3CHClCH_2Cl$

---

33 Four $C_{10}H_{14}$ isomers are named below. Which of these would display the following ^{1}Hnmr signals?
δ 1.22 (t) 6H , δ 2.60 (q) 4H , δ 7.12 (s) 4H (s=singlet, d=doublet, t=triplet, q=quartet, ,m=multiplet)
○ A) *tert*-butylbenzene.
○ B) isobutylbenzene.
○ C) *para*-diethylbenzene.
○ D) 1,2,3,4-tetramethylbenzene.

---

34 Four $C_{10}H_{14}$ isomers are named below. Which of these would display the following ^{1}Hnmr signals?
δ 2.18 (s) 12H , δ 6.88 (s) 2H (s=singlet, d=doublet, t=triplet, q=quartet, ,m=multiplet)
○ A) *tert*-butylbenzene.
○ B) 1,2,4,5-tetramethylbenzene.
○ C) 1,2,3,5-tetramethylbenzene.
○ D) 1,2,3,4-tetramethylbenzene.

---

35 An unknown compound has a molecular ion at m/z=79 amu in its mass spectrum. Analysis shows its composition to be 17.7% nitrogen.
What is the molecular formula of this compound?
○ A) C_5H_5N.
○ B) $C_4H_3N_2$.
○ C) C_3HN_3.
○ D) $C_4H_{17}N$..

---

36 The infrared spectrum of a hydrocarbon has a strong absorption at 3297 cm^{-1}. What structural feature does this indicate?
○ A) sp^3 C–H
○ B) sp^2 C–H

○ C) sp C–H
○ D) C≡C

---

37 Four $C_{10}H_{14}$ isomers are named below. Which of these would display the following ^{1}Hnmr signals?
δ 0.88 (d) 6H , δ 1.86 (m) 1H , δ 2.45 (d) 2H , δ 7.2-7.3 (s) 5H (s=singlet, d=doublet, t=triplet, q=quartet, ,m=multiplet)
○ A) *para*-isopropyltoluene.
○ B) isobutylbenzene.
○ C) *sec*-butyllbenzene.
○ D) *meta*-diethylbenzene.

---

38 Two isomeric C_8H_{10} hydrocarbons (**A** & **B**) both give the same C_8H_{14} saturated hydrocarbon product on exhaustive catalytic hydrogenation.
Both A & B show strong UV absorption at λ_{max} = 245 nm, and addition of **one equivalent of HBr** to either A or B produces the same mixture of $C_8H_{13}Br$ isomers.
The ^{13}C nmr of A has five signals, two from sp^2 carbons & three from sp^3 carbons.
The ^{13}C nmr of B has four signals, two from sp^2 carbons & two from sp^3 carbons.
What are reasonable assignments for A and B, choosing from structures 1 through 4?


1 2 3 4

○ A) A = 1 ; B = 2
○ B) A = 2 ; B = 3
○ C) A = 3 ; B = 4
○ D) A = 4 ; B = 3

---

39 Neopentyl chloride, $(CH_3)_3CCH_2Cl$, reacts with the strong base sodium amide to form a new compound
This compound has a molecular ion at m/z = 70 amu, and displays two ^{1}H nmr singlets at δ 0.20 & 1.05 ppm (intensity ratio = 2**:**3)
What is a plausible structure for this compound ?
○ A) 2-methyl-2-butene
○ B) 1,1-dimethylcyclopropane
○ C) methylcyclobutane
○ D) cyclopentane

---

40 A compound has a molecular ion at m/z = 142 amu, and displays only one ^{1}H nmr signal (a sharp singlet).
Which of the following satisfies these facts?
○ A) methyl iodide
○ B) 1,1,2,2-tetra fluorocyclopentane
○ C) *para*-disulfhydrylbenzene [$C_6H_4(SH)_2$]
○ D) 2,4-hexadiyne-1,6-diol

---

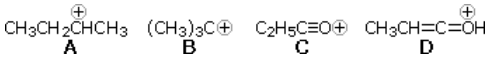
41 Which of the following statements is the best definition of the **base peak** in a mass spectrum?
○ A) the molecular ion peak
○ B) the lowest m/z peak
○ C) the highest mass rearrangement ion
○ D) the ion peak of greatest intensity

---

42 Assuming all the compounds listed below yield an observable molecular ion, which would have an odd number m/z value for this ion?
○ A) $C_9H_{15}F$
○ B) $C_7H_{10}N_2O$
○ C) $C_8H_{10}NI$
○ D) all the above have odd mass molecular ions

---

43 The mass spectrum of 3-pentanone has a very large ion peak at m/z = 57.
Which of the following ions is thought to be responsible for this peak?


A B C D

---

44 Four methyl compounds are listed below. Which has the lowest field methyl resonance in the ^{1}H nmr spectrum?
○ A) $(CH_3)_4Si$
○ B) $(CH_3)_3N$
○ C) $(CH_3)_2S$
○ D) $(CH_3)_2O$

---

45 The following hydrocarbons all have ^{1}H nmr spectra consisting of a single sharp peak
Which exhibits the greatest shielding?
○ A) 2-butyne
○ B) benzene
○ C) 1,2,3-butatriene
○ D) 1,3-butadiyne

---

46 Infrared spectroscopy examines energy excitations in which of the following ranges?

- A) 0.01 to 0.1 kcal/mol
- B) 1 to 10 kcal/mol
- C) 10 to 50 kcal/mol
- D) 50 to 100 kcal/mol

---

47 A $C_5H_{12}O_2$ compound has strong infrared absorption at 3300 to 3400 cm^{-1}.

The ^1H NMR spectrum has three singlets at δ 0.9 , δ3.45 and δ3.2 ppm; relative areas 3:2:1. Addition of D_2O to the sample eliminates the lower field signal.

The ^{13}C NMR spectrum shows three signals all at higher field than δ100 ppm.

Which of the following compounds best fits this data?

- A) 1,5-pentanediol
- B) 1,3-dimethoxypropane
- C) 2,2-dimethyl-1,3-propanediol
- D) 2,4-pentanediol

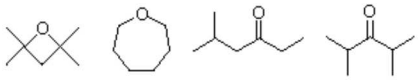
---

48 A $C_7H_{14}O$ compound has a strong infrared absorption at 1715 cm^{-1}.

The ^1H NMR spectrum consists of two signal groups: δ 1.10 ppm (d) and δ 2.77 (m), ratio 6**:**1.

The ^{13}C NMR spectrum shows three lines at δ218, 39 and 18 ppm.

Which of the following compounds best fits this data?



A ○ B ○ C ○ D ○

---

49 A $C_9H_{12}O_3$ compound has two strong infrared absorptions between 1100 and 1250 cm^{-1} and at 1600 cm^{-1}.

The ^1H NMR spectrum has sharp singlet peaks at δ 3.6 and 6.6 ppm (intensity ratio 3:1).

The ^{13}C NMR spectrum shows three lines at δ 165, 115 and 55 ppm.

Which of the following compounds best fits this data?

- A) 1,3,5-trimethoxybenzene
- B) 1,2,3-trimethoxybenzene
- C) 2,4,6-trimethyl-1,3,5-benzenetriol
- D) 1-phenyl-1,2,3-propanetriol

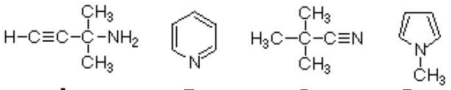
---

50 An unknown compound displays a molecular ion at m/z = 83 amu

The ^{13}C NMR spectrum shows three lines at δ 126, 28.5 and 28.1 ppm.

The infrared spectrum shows a sharp strong absorption at 2235 cm^{-1}.

Which of the following compounds best fits this data?



A ○ B ○ C ○ D ○

---

51 An infrared spectrum has a strong absorption at 5.85 μ. Which of the following frequencies corresponds to this wavelength?

- A) 3300 cm^{-1}
- B) 1710 cm^{-1}
- C) 1200 cm^{-1}
- D) 890 cm^{-1}

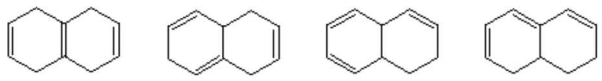
---

52 Which of the following statements is **not correct**.?

- A) frequencies in cm^{-1} are much smaller numbers than frequencies in Hz
- B) wavelengths in μ are smaller numbers than wavelengths in Å
- C) frequency varies inversely with wavelength
- D) wavelengths given in nm are larger numbers than wavelengths in Å

---

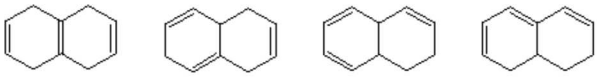
53 Which of the following trienes will have the longest wavelength absorption in the ultraviolet?



A ○ B ○ C ○ D ○

---

54 Which of the following trienes will have the simplest ^1Hnmr spectrum?



A ○ B ○ C ○ D ○

Check Answers Reset/Clear View Answers

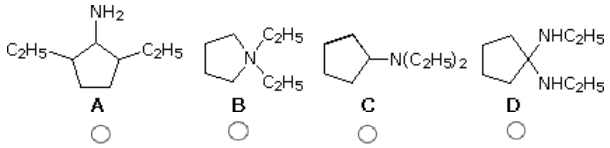
Amines and Related Nitrogen Compounds

1. Which of the following is a 3º-amine?

- A) 1-methylcyclohexylamine
- B) triethylamine
- C) *tert*-butylamine
- D) N-methylaniline

---

2. Which of the following compounds is cyclopentyldiethylamine?



---

3 Which of the following is a proper name for $CH_2=CHCH_2NHCH_3$?

- A) allylmethylamine
- B) 4-amino-1-pentene
- C) 2-amino-4-pentene
- D) N-methyl-1-propenamine

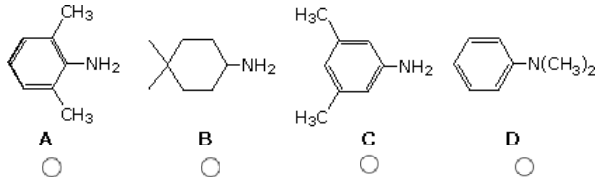
---

4 Which of the following is tetrabutylammonium iodide?

- A) $C_4H_9NH_3^+ I^-$
- B) $C_4H_9N(CH_3)_3^+ I^-$
- C) $(C_4H_9)_4N^+ I^-$
- D) $(CH_3)_4N^+ I^-$

---

5 Which of the following is N,N-dimethylaniline?



---

6 Which of the following is a proper name for $(CH_3)_2CHCH_2NHCH_2CH_2CH(CH_3)_2$?

- A) 2,7-dimethyl-4-azaoctane
- B) butylpentylamine
- C) 2,7-dimethylpropylbutylamine
- D) 3-amino-2,7-dimethyloctane

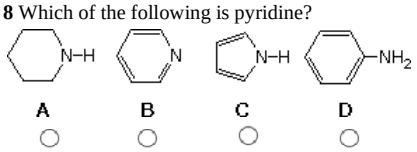
---

7 Ethylmethylamine cannot be resolved under normal conditions. Why?

- A) the favored configuration is not chiral.
- B) it isomerizes rapidly with the achiral isomer trimethylamine.
- C) the nitrogen atom rapidly inverts its configuration leading to a racemic mixture.
- D) the C–N bond is not stable under conditions used for resolution

---

8 Which of the following is pyridine?



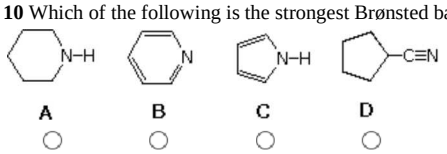
---

9 Which of the following is the strongest base in aqueous solution?.

- A) $(CH_3)_3N$
- B) $(CH_3)_2N\ CH_2CH_2OH$
- C) $CH_3CH_2CH_2NHOH$
- D) $(CH_3)_4N\ OH$

---

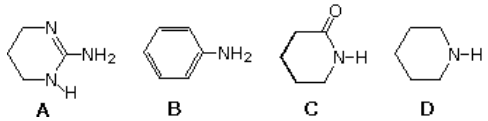
10 Which of the following is the strongest Brønsted base?



11 Dibutylamine, $(C_4H_9)_2NH$, and anisole, $C_6H_5OCH_3$, have similar boiling points, and are relatively insoluble in water.
How might a mixture of these compounds be separated into the pure components?

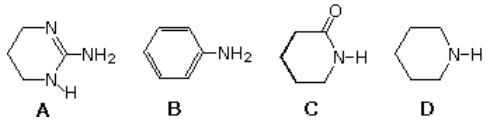
- A) **i)** dissolve mixture in ether; **ii)** extract the anisole into 10% aqueous NaOH
- B) **i)** dissolve mixture in ether; **ii)** extract the amine into 10% aqueous HCl
- C) **i)** dissolve mixture in ether; **ii)** extract the amine into 10% aqueous NaOH
- D) **i)** dissolve mixture in ether; **ii)** extract the anisole into 10% aqueous HCl

12 Which of the following is the strongest Brønsted acid?



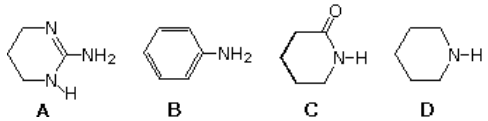
A B C D

13 Which of the following is the strongest Brønsted base?



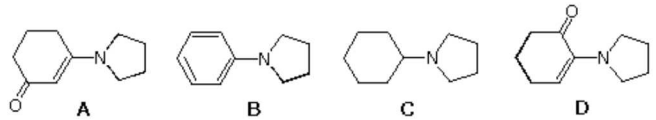
A B C D

14 Which of the following is the weakest Brønsted base?



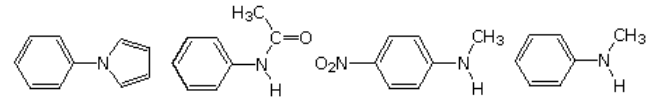
A B C D

15 Which of the following is the weakest Brønsted base?



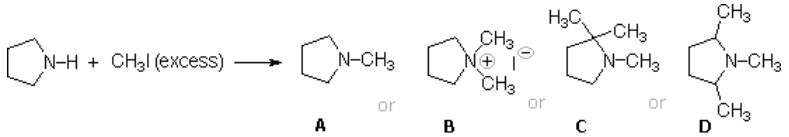
A B C D

16 Which of the following is the strongest Brønsted base?



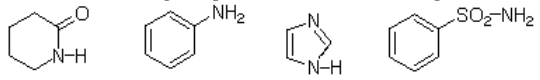
A B C D

17 Which compound is the likely product from reaction of pyrrolidine with excess methyl iodide (equation below)?



A or B or C or D

18 For the following compounds, which is the **strongest base** and which the **strongest acid** ?

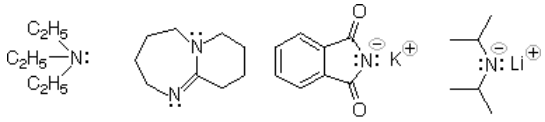


I II III IV

- A) II = strongest base, I = strongest acid
- B) IV = strongest base, III = strongest acid
- C) III = strongest base, IV = strongest acid
- D) II = strongest base, III = strongest acid

III = strongest base, IV = strongest acid

19 Basic reagents are used in many organic reactions. Examples are: I triethylamine, II DBU, III potassium phthalimide & IV LDA.
Which of these is the strongest base?



A ○ B ○ C ○ D ○

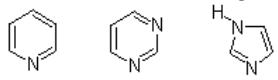
---

20 Benzylamine may be alkylated as shown in the following equation.
$C_6H_5CH_2NH_2$ + R-X ----> $C_6H_5CH_2NHR$ (pyridine is used to scavange the HX produced here)
Which of the following alkyl halides is best suited for this reaction?

○ A) $(CH_3)_3CCH_2Br$
○ B) C_6H_5Br
○ C) $C_6H_5CH_2Br$
○ D) $(CH_3)_3CCl$

---

21 Three heterocyclic amines are shown below: I = pyridine, II = pyrimidine, III = imidazole.
What is the order of increasing basicity? (weaker base < stronger base)



I II III

○ A) II < I < III
○ B) II < III< I
○ C) I < II < III
○ D) III < II < I

---

22 Which of the following reagents **would not** be a good choice for reducing an aryl nitro compound to an amine?

○ A) H_2 (excess) & Pt catalyst
○ B) $LiAlH_4$ in ether
○ C) Fe in 15% HCl
○ D) Zn in 10% HCl

---

23 What reagent is the source of nitrogen in the Gabriel synthesis of amines?

○ A) sodium azide, NaN_3
○ B) sodium nitrite, $NaNO_2$
○ C) potassium cyanide, KCN
○ D) potassium phthalimide, $C_6H_4(CO)_2NK$

---

24 In order to prepare a 1º-amine incorporating an additional CH_2 group from an alkyl halide, what reagent is often used as the nitrogen source?

○ A) sodium amide, $NaNH_2$
○ B) sodium azide, NaN_3
○ C) potassium cyanide, KCN
○ D) potassium phthalimide, $C_6H_4(CO)_2NK$

---

25 What set of conditions would be useful for preparing a 2º-amine?

○ A) 2º-RBr + $NaNH_2$
○ B) **(i)** 2º-RBr + NaN_3 **(ii)** H_2 & Pt
○ C) **(i)** 1º-RNH_2 + 1º-RCHO **(ii)** H_2 & Pt
○ D) **(i)** 2 1º-RBr + potassium phthalimide **(ii)** H_3O^+ & heat

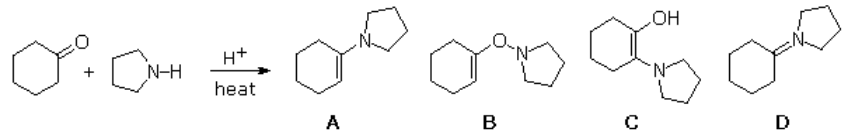
---

26 What reagent is used in the Hinsberg test of amines?

○ A) $(CH_3CO)_2O$ & pyridine
○ B) $C_6H_5SO_2Cl$ in aq. NaOH
○ C) $NaNO_2$ in aq. H_2SO_4
○ D) CH_3I (excess) followed by AgOH

---

27 Which of the following will be the favored product from the reaction shown below?



A ○ B ○ C ○ D ○

---

28 Which of the following procedures would be best for preparing isobutylisopropylamine, $(CH_3)_2CHNHCH_2CH(CH_3)_2$?

○ A) $(CH_3)_2CHBr + (CH_3)_2CHCH_2NH_2$
○ B) **(i)** $(CH_3)_2CHBr + (CH_3)_2CHCONHNa$ **(ii)** $LiAlH_4$ in ether
○ C) **(i)** $(CH_3)_2CHNH_2 + (CH_3)_2CHCH{=}O$ **(ii)** H_2 & Pt
○ D) $(CH_3)_2CHCN + (CH_3)_2CHNH_2$

---

29 What is the chief product from the Hofmann elimination of 4-methyl-2-aminopentane?
○ A) 4-methyl-1-pentene
○ B) 4-methyl-2-pentene
○ C) 2-methyl-1-pentene
○ D) 2-methyl-2-pentene

---

30 Which of the following procedures would be best for preparing dimethylcyclohexylamine, $C_6H_{11}N(CH_3)_2$?
○ A) **(i)** dimethylamine + cyclohexanone **(ii)** $NaBH_3CN$ in methanol
○ B) dimethylamine + cyclohexylbromide in ether
○ C) cyclohexylamine + 2 CH_3I in ether
○ D) **(i)** cyclohexylbromide + NaCN in methanol **(ii)** 2 CH_3Li in THF

---

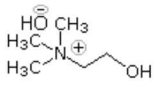
31 What reagent would be best for converting the amide of (R)-2-phenylpropanoic acid, $C_6H_5CH(CH_3)CONH_2$, into (R)-1-amino-2-phenylpropane?
○ A) excess H_2 & Pt.
○ B) NaOBr in aqueous base.
○ C) $NaBlH_4$ in methanol
○ D) $LiAlH_4$ in ether.

---

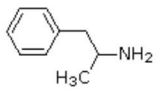
32 What reagent would be best for converting the amide of (R)-2-phenylpropanoic acid, $C_6H_5CH(CH_3)CONH_2$, into (R)-1-phenylethylamine?
○ A) excess H_2 & Pt.
○ B) NaOBr in aqueous base.
○ C) $NaBlH_4$ in methanol
○ D) $LiAlH_4$ in ether.

---

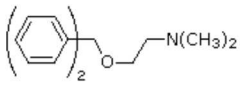
33 The structural formulas of four physiologically active amines are displayed below.
choline is a nerve transmission agent, benzedrine is an amphetamine, benadryl is an antihistamine, and coniine is a toxic alkaloid found in hemlock.
Which of these would be classified as a tertiary amine?



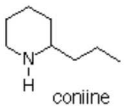
choline



benzedrine



benadryl



coniine

○ A) choline
○ B) benzedrine
○ C) benadryl
○ D) coniine

---

34 Many kinds of amino alcohols are known, but α-amino alcohols such as 1-dimethylaminocyclopentanol are not stable under most conditions.
Which of the following statements best accounts for their instability?
○ A) carbon does not like to form bonds to two more electronegative atoms such as O and N.
○ B) the α-isomer rapidly rearranges to the more stable β amino alcohol.
○ C) rapid loss of water (a stable small molecule) leads to an imine product.
○ D) rapid loss of amine leads to a stable carbonyl compound (aldehyde or ketone).

---

35 Which of the following amines reacts most rapidly with para-nitrophenylacetate, $p\text{-}NO_2C_6H_4OCOCH_3$?
○ A) para-methoxyaniline,.$p\text{-}CH_3OC_6H_4NH_2$
○ B) para-nitroaniline, $p\text{-}NO_2C_6H_4NH_2$.
○ C) aniline, $C_6H_5NH_2$.
○ D) cyclopentylamine, $C_5H_9NH_2$.

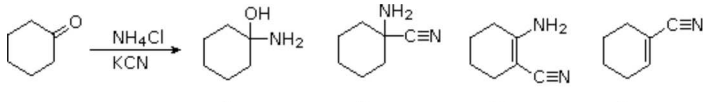
---

36 What product mixture is expected from reaction of (S)-2-aminobutane with 2-butanone in the presence of $NaBH_3CN$?
○ A) a pair of enantiomers.
○ B) a pair of diastereomers, both meso.
○ C) a pair of diastereomers, one meso one chiral.
○ D) a pair of diastereomers, both chiral (not enantiomers).

---

37 Which of the following compounds is the strongest base?
○ A) $(CH_3)_2NCH_2CO_2CH_3$.
○ B) $(CH_3)_2NCOCH_3$.
○ C) $(CH_3)_2NC{\equiv}N$.
○ D) $(CH_3)_2N\text{-}N{=}O$.

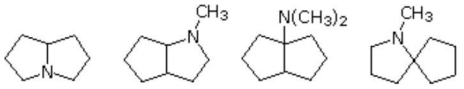
38 What is the chief product from the following reaction?



A ○ B ○ C ○ D ○

39 The nitrogen atom in each of the following tertiary amines may be removed as trimethyl amine by repeated Hofmann eliminations (exhaustive methylation followed by heating with AgOH).

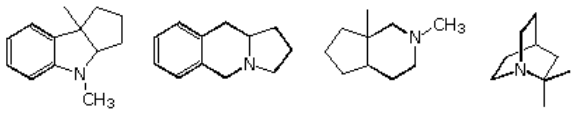
Which of the amines requires the greater number of Hofmann sequences to accomplish this?



A ○ B ○ C ○ D ○

40 Only one of the following amines will lose its nitrogen atom as trimethyl amine by repeated Hofmann elimination reactions (exhaustive methylation followed by heating with AgOH).

Identify that amine.



A ○ B ○ C ○ D ○

41 A nitrogen containing compound dissolves in 10% aq. sulfuric acid..

The Hinsberg test ($C_6H_5SO_2Cl$ in base) gives a solid product that is not soluble in 10% aq. NaOH..

Which of the following would best fit these facts?

○ A) N,N-dimethylaniline, $C_6H_5N(CH_3)_2$.
○ B) N-methylbenzamide, $C_6H_5CONHCH_3$.
○ C) N-methylaniline, $C_6H_5NHCH_3$.
○ D) benzylamine, $C_6H_5CH_2NH_2$.

42 Which of the following reagents would be best for converting phenylacetamide ($C_6H_5CH_2CONH_2$) to benzylamine ($C_6H_5CH_2NH_2$)?

○ A) $LiAlH_4$ in ether.
○ B) **i)** P_2O_5 & heat; **ii)** $LiAlH_4$ in ether.
○ C) H_2 & Pt catalyst.
○ D) aqueous NaOBr.

43 The Hinsberg test of a $C_5H_{14}N_2$ compound produces a solid that is insoluble in 10% aq. NaOH.

This solid derivative dissolves in 10% aq. sufuric acid. Which of the following would best fit these facts?

○ A) $NH_2CH_2CH_2CH_2N(CH_3)_2$.
○ B) $(CH_3)_2NCH_2CH_2NHCH_3$.
○ C) $NH_2CH_2C(CH_3)_2CH_2NH_2$.
○ D) $(CH_3)_2NCH_2N(CH_3)_2$.

44 Which of the following reagents and conditions would be best for the preparation of cyclohexylamine?

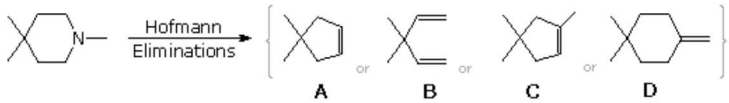
○ A) cyclohexanone + NH_3 + $NaBH_3CN$.
○ B) cyclohexylbromide + 2 NH_3.
○ C) cyclohexylbromide + $NaNH_2$.
○ D) cyclohexene + NH_3.

45 Which of the following reagents would be best for converting phenylacetamide ($C_6H_5CH_2CONH_2$) to phenethylamine ($C_6H_5CH_2CH_2NH_2$)?

○ A) H_2 & Pt catalyst.
○ B) $NaBH_3CN$.
○ C) $LiAlH_4$ in ether.
○ D) aqueous NaOBr.

46 Repeated Hofmann elimination reactions (exhaustive methylation followed by heating with AgOH) will often remove a nitrogen atom from an amine molecule.

Which of the following compounds is the likely product in this case?



A B C D

○ ○ ○ ○

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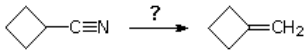
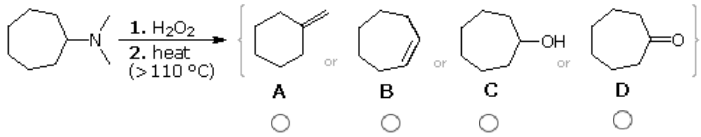
47 What sequence of reactions would best accomplish the following reaction?



○ A) **i)** $LiAlH_4$ in ether; **ii)** 3 CH_3I followed by heating with AgOH
○ B) **i)** $LiAlH_4$ in ether; ; **ii)** P_2O_5 & heat
○ C) **i)** 20% H_2SO_4 & heat; **ii)** P_2O_5 & heat
○ D) H_2 & Lindlar catalyst

---

48 What is the likely product from the following reaction?



○ ○ ○ ○

---

49 Which of the following statements concerning amine oxides **is not** true?
○ A) chiral amine oxides may be resolved.
○ B) the nitrogen has a positive formal charge.
○ C) the nitrogen hybridization is sp^3.
○ D) all types of amines can form amine oxide derivatives.

---

50 Amines are well known to be stronger bases and nucleophiles than alkenes.
Why do enamines, such as 1-dimethylaminocyclopentene, preferentially react with electrophiles at a double bond carbon rather than at nitrogen?
○ A) the nitrogen is sterically hindered by alkyl substituents.
○ B) nitrogen is more electronegative than carbon.
○ C) the carbocation formed by electrophilic attack at C-2 is stabilized by pi-bonding with the lone pair of electrons on nitrogen.
○ D) ammonium cations are less stable than carbocations.

---

51 A $C_5H_{13}N$ compound gives a base soluble derivative in the Hinsberg test ($C_6H_5SO_2Cl$ in base).
The ^{13}Cnmr spectrum of this compound has four resonance signals at δ 8.7, 29.9, 37.5 & 49.5 ppm.
Which of the following fits these facts best?
○ A) 1,1-dimethylpropylamine.
○ B) isopropyldimethylamine.
○ C) 2,2-dimethylpropylamine.
○ D) N-methyl-2-methylpropylamine.

---

52 Reaction of *para*-chloroaniline with acetic anhydride in pyridine gave a mixture of 94% of *para*-chloroacetanilide, contaminated with 6% unreacted amine.
Which of the following treatments would be best used to purify the amide?
○ A) react the unreacted amine with methyl iodide.
○ B) wash an ether solution of the crude product with concentrated brine (aq. NaCl).
○ C) wash an ether solution of the crude product with 5% aqueous sulfuric acid.
○ D) wash an ether solution of the crude product with 5% aqueous sodium carbonate.

Check Answers | Reset/Clear | View Answers

Aldehydes and Ketones

1. Which of the following is a correct name for $(CH_3)_2C{=}CHCOCH_3$?

- A) 2-methyl-2-penten-4-one
- B) 4-methyl-3-penten-2-one
- C) 1,3-dimethyl-2-pentenal
- D) isopentenone

---

2. Which of the following is 3,3-diphenylpropanal?

- A) $C_6H_5CH_2CH(C_6H_5)CHO$
- B) $C_6H_5CH_2CH_2COC_6H_5$
- C) $(C_6H_5)_2CHCH_2CHO$
- D) $(C_6H_5)_2CHCH_2COC_6H_5$

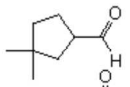
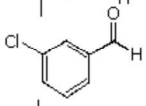
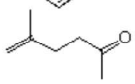
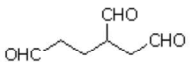
---

3. Which of the following compounds is not named correctly?

- **A**) 2-methyl-3-heptanone $(CH_3)_2CHCOCH_2CH_2CH_2CH_3$
- **B**) phenylacetaldehyde $C_6H_5CH_2CHO$
- **C**) 4-hexyn-2-one $CH_3COCH_2C{\equiv}CCH_3$
- **D**) para-bromoacetophenone $p\text{-}BrC_6H_4CH_2COCH_3$

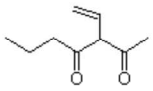
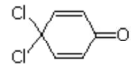
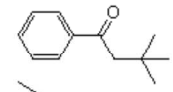
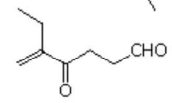
---

4. Which of the following compounds is not named correctly?

- **A**  3,3-dimethylcyclopentylcarbaldehyde
- **B**  meta-chlorobenzaldehyde
- **C**  2-methyl-1-penten-4-one
- **D**  3-formylhexanedial

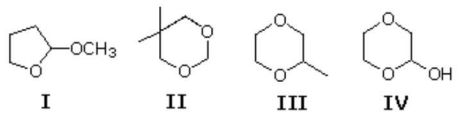
---

5. Which of the following compounds is not named correctly?

- **A**  3-vinyl-2,4-heptanedione
- **B**  4,4-dichloro-2,5-cyclohexadien-1-one
- **C**  3,3-dimethyl-1-phenyl-1-butanone
- **D**  5-methylene-4-oxo-heptanal

---

6 Which of the following may be classified as an **acetal**?



I II III IV

- A) I & II
- B) III & IV
- C) only IV
- D) all but IV

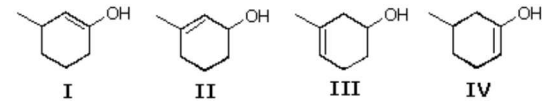
---

7 Which of the following reactions is a good method for preparing an aldehyde?

- A) Jones' reagent and a 1º-alcohol
- B) Jones' reagent and a 2º-alcohol
- C) PCC and a 1º-alcohol
- D) H_2SO_4 a 1º-alcohol and heat

---

8 Which of the following are enol tautomers of 3-methylcyclohexanone?



- A) I & II
- B) I & IV
- C) II & III
- D) only I

---

9 Which of the following statements **is not** generally true?

- A) C=O is stronger than an equivalent C=C
- B) C=O has a larger bond dipole than C=C
- C) aldehydes and ketones have higher boiling points than similarly sized alkenes
- D) alkenes add nucleophiles more rapidly than aldehydes or ketones of similar structure

---

10 Which of the following compounds exchanges the largest number of hydrogens for deuterium when treated with KOD in D_2O?

- A) 3-methyl-1,2-cycloheptanedione
- B) 2-methyl-1,3-cycloheptanedione
- C) 5-methyl-1,3-cycloheptanedione
- D) 6-methyl-1,4-cycloheptanedione

---

11 Four $C_8H_{14}O$ ketones are examined by ^{13}Cnmr spectroscopy.
One of them has five distinct carbon signals. Which of the following fits this fact?

- A) 4,4-dimethylcyclohexanone
- B) 3,3-dimethylcyclohexanone
- C) 2,2-dimethylcyclohexanone
- D) 2,2,4,4-tetramethylcyclobutanone

---

12 Which of the following compounds **could not** be converted to pentanal in one or two steps?

- A) 1-pentyne
- B) *trans*-5-decene
- C) 2-pentanone
- D) 1-pentanol

---

13 Treatment of cyclohexanone with an excess of $H_2{}^{18}O$ produces ^{18}O labeled cyclohexanone.
Which of the following is a likely intermediate in this isotope exchange? (the isotope is not named)

- A) 1-cyclohexen-1-ol
- B) 1,1-cyclohexanediol
- C) 2-cyclohexen-1-one
- D) 1,2-cyclohexanediol

---

14 Reaction of $C_6H_5CHBr_2$ with NaOH in aqueous THF is likely to produce which product?

- A) $C_6H_5CHBrOH$
- B) $C_6H_5CH(OH)_2$
- C) C_6H_5CHO
- D) $C_6H_5CO_2H$

---

15 Which of the following carbonyl compounds reacts most rapidly with nucleophilic reagents?

- A) benzaldehyde
- B) 3,3-dimethylbutanal
- C) acetophenone
- D) 2,2-dimethylcyclohexanone

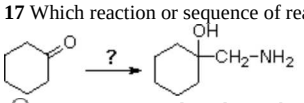
---

16 Which of the following amines would be best chosen for preparing an enamine derivative from cyclohexanone?

- A) dimethylamine
- B) ethylamine
- C) trimethylamine
- D) hydroxylamine

---

17 Which reaction or sequence of reactions would best accomplish the following synthesis?



- A) CH_3NH_2, acid catalyst & heat
- B) CH_2=NH, acid catalyst & heat
- C) **(i)** NH_3 acid catalyst & heat; **(ii)** CH_2I_2 & Zn(Cu)
- D) **(i)** HCN & NaCN; **(ii)** $LiAlH_4$ in ether

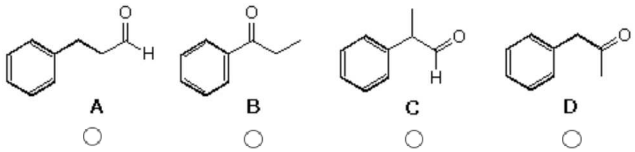
18 Heating cyclopentanone with either: **I** ethyl amine, or **II** diethylamine, together with an acid catalyst leads to different results.
Which of the following best describes this difference?

- A) **I** gives an imine & **II** fails to react
- B) **I** gives an enamine & **II** fails to react
- C) **I** gives an imine & **II** gives an enamine
- D) **I** gives an enamine & **II** gives an imine

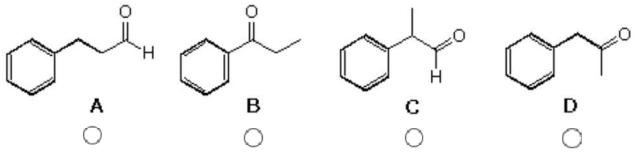
19 Which reaction or sequence of reactions would be best used to convert cyclohexanone to *cis*-1,2-cyclohexanediol?

- A) PCC in CH_2Cl_2 and base
- B) **(i)** $NaBH_4$; **(ii)** H_3PO_4 & heat; **(iii)** OsO_4 in pyridine
- C) **(i)** $NaBH_4$; **(ii)** H_3PO_4 & heat; **(iii)** $C_6H_5CO_3H$
- D) **(i)** $NaBH_4$; **(ii)** OsO_4 in pyridine

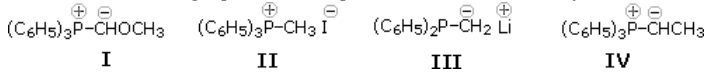
20 A $C_9H_{10}O$ compound has a strong absorption at 1686 $^{-1}$cm in the infrared.
Which of the following compounds would be expected to display such an absorption band?



21 A $C_9H_{10}O$ compound has a strong absorption at 1730 and two smaller but sharp absorption peaks at 2719 & 2818 $^{-1}$cm in the infrared. The ^{1}Hnmr has a strong doublet at δ1.0 ppm.
Which of the following compounds would be expected to display these features?



22 The Wittig reaction takes place between a carbonyl compound and a phosphorus ylid.
Which of the following represents the dipolar contributor to such an ylide?



- A) I & II
- B) II only
- C) III only
- D) I & IV

23 Which of the following reaction sequences would be best for converting cyclohexanol to methylenecyclohexane, $(CH_2)_5C{=}CH_2$?

- A) **(i)** H_3PO_4 & heat; **(ii)** CH_2I_2 + Zn(Cu)
- B) **(i)** PCC in CH_2Cl_2; **(ii)** CH_3MgBr; **(iii)** H_3PO_4 & heat
- C) PCC in CH_2Cl_2; **(ii)** $(C_6H_5)_3P{=}CH_2$
- D) CH_2N_2 & heat

24 Which of the following Wittig reagents would be useful for converting $R_2C{=}O$ into $R_2CHCH{=}O$?

- A) $(C_6H_5)_3P{=}CH\text{-}OCH_3$
- B) $(C_6H_5)_3P{=}CH\text{-}CH_3$
- C) $(C_6H_5)_3P{=}Cl_2$
- D) $(C_6H_5)_3P{=}CH\text{-}CH{=}CH_2$

25 Two equivalents of the Wittig reagent $(CH_3)_2C{=}CH\text{-}CH{=}P(C_6H_5)_3$ were allowed to react with a $C_4H_4O_2$ compound.
The chief product was 2,11-dimethyl-2,4,6,8,10-dodecapentaene, $(CH_3)_2C{=}CH(CH{=}CH)_3CH{=}C(CH_3)_2$.
What was the $C_4H_4O_2$ compound used in this reaction?

- A) 2-butyne-1,4-diol
- B) 1,2-cyclobutanedione
- C) 1,3-butadien-2,3-diol
- D) 2-butenedial

26 Which of the following reactions **would not** be a useful way of preparing 1-phenyl-2-butanol?

- A) phenylacetaldehyde + ethylmagnesium bromide
- B) butanal + phenylmagnesium bromine
- C) propanal + benzylmagnesium bromine
- D) 1-phenyl-2-butanone + $NaBH_4$

27 Which of the following reactions **would not** be a useful way of preparing 2-phenyl-2-butanol?

- A) 2-butanone + phenylmagnesium bromine
- B) acetophenone + ethylmagnesium bromide
- C) cis-2,3-dimethyloxirane + phenylmagnesium bromide
- D) ethylphenylketone + methylmagnesium iodide

---

28 In the reaction of (R)-3-phenyl-2-butanone with methylmagnesium iodide, what happens to the configuration of the stereogenic center?

- A) nothing, it remains unchanged
- B) inversion takes place
- C) racemization occurs
- D) the product is achiral

---

29 Which of the following reactions would not be useful for converting 4,4-diethylcyclohexanone into 1,1-diethylcyclohexane?

- A) Wolff-Kishner reduction (N_2H_4, strong base & heat)
- B) Clemmensen reduction (Zn/Hg, acid & heat)
- C) thioacetal reduction (**i** $HSCH_2CH_2SH$ & BF_3; **ii** H_2 + Raney Ni)
- D) $LiAlH_4$ in THF & heat

---

30 Which of the following is a semicarbazone derivative of an aldehyde (RCHO)?

- A) $RCH{=}N\text{-}NHCONH_2$
- B) RCH=N-OH
- C) $RCH{=}N\text{-}NH_2$
- D) $RCH{=}N\text{-}C(CH_3)_3$

---

31 Which of the following isomers is most acidic ?

- A) 3,4-hexanedione
- B) 2,5-hexanedione
- C) 2,4-hexanedione
- D) hexanedial

---

32 You have two $C_6H_{10}O$ ketones, **I** and **II**. Both are optically active, but **I** is racemized by treatment with base and **II** is not.
Wolff-Kishner reduction of both ketones gives the same achiral hydrocarbon, formula C_6H_{12}.
What reasonable structures may be assigned to **I** and **II**?

- A) **I** is 3-methyl-4-penten-2-one; **II** is 4-methyl-1-penten-3-one
- B) **I** is 2-methylcyclopentanone; **II** is 3-methylcyclopentanone
- C) **I** is 3-methylcyclopentanone; **II** is 2-methylcyclopentanone
- D) **I** is 2-ethylcyclobutanone; **II** is 3-ethylcyclobutanone

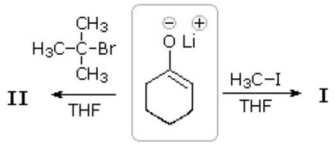
---

33 Jones' reagent oxidizes aldehydes to carboxylic acids but normally does not oxidize ketones.
What intermediate species is most likely responsible for the aldehyde oxidation?

- A) a carbonyl hydrate
- B) an enol tautomer
- C) an oxonium conjugate acid of the aldehyde
- D) an acylium cation

---

34 The lithium enolate base from cyclohexanone reacts with alkyl halides, often in different ways.
As shown here, methyl iodide and *tert*-butyl bromide react to give different organic products, **I** and **II**, together with lithium halides.
What are the products from these reactions?



- A) **I** is 2-methylcyclohexanone; **II** is 2-t-butylcyclohexanone
- B) **I** is 1-methoxycyclohexene; **II** is 1-t-butoxycyclohexene
- C) **I** is 2-methylcyclohexanone; **II** is 1-t-butoxycyclohexene
- D) **I** is 2-methylcyclohexanone; **II** is a mixture of cyclohexanone and 2-methylpropene

---

35 A $C_5H_{12}O$ compound is optically active, and is oxidized by PCC in CH_2Cl_2 to an optically active $C_5H_{1O}O$ product, which is racemized in acid or base.
Which of the following best fits these facts?

- A) 2-pentanol
- B) 2-methoxybutane
- C) 2-methyl-1-butanol
- D) 3-methyl-1-butanol

---

36 Which of the following aldehydes, used alone, will undergo an aldol reaction?

- A) formaldehyde, CH_2O

B) butanal, $CH_3(CH_2)_2CHO$
C) benzaldehyde, C_6H_5CHO
D) 2-propenal, CH_2=CHCHO

---

37 Which of the following reaction sequences would be best for preparing 2,2-dimethyl-3-hexanone from butanal?
A) **(i)** addition of *tert*-butylmagnesium bromide in ether; **(ii)** hydrolysis workup; **(iii)** PCC in CH_2Cl_2
B) **(i)** $NaBH_4$; **(ii)** PBr_3; **(iii)** Mg in ether; **(iv)** 2,2-dimethylpropanal, followed by hydrolysis
C) **(i)** Wittig reaction with $(C_6H_5)_3P$=$C(CH_3)_2$; **(ii)** BH_3 in THF; **(iii)** H_2O_2 & base; **(iv)** PCC in CH_2Cl_2
D) **(i)** Wittig reaction with $(C_6H_5)_3P$=$CHC(CH_3)_3$; **(ii)** BH_3 in THF; **(iii)** H_2O_2 & base; **(iv)** PCC in CH_2Cl_2

---

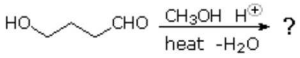
38 How can 1,1,1,2,2-pentadeutero-3,3-dimethylpentane, $C_2H_5C(CH_3)_2C_2D_5$, be prepared from 3,3-dimethyl-2-pentanone?
A) **(i)** NaOD in D_2O (excess); **(ii)** $LiAlD_4$ in ether; **(iii)** D_2O workup
B) **(i)** Wolff-Kishner reduction with N_2D_4 in ROD; **(ii)** NaOD in D_2O (excess)
C) **(i)** Zn & DCl in CH_3CO_2D; **(ii)** $LiAlD_4$ in ether; **(iii)** D_2O workup
D) **(i)** NaOD in D_2O (excess); **(ii)** $HSCH_2CH_2SH + BF_3$; **(iii)** D_2 + Raney Ni catalyst

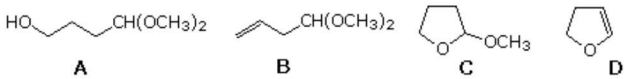
---

39 Acetaldehyde reacts with (R)-1,2-propanediol (acid catalyst) to give two isomeric acetals. What is their isomeric relationship?
A) they are constitutional isomers
B) 2 they are diastereomers
C) 3 they are enantiomers
D) they are conformers

---

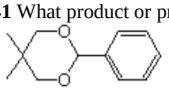
40 What is the product of the following reaction?





---

41 What product or products are expected from acid-catalyzed hydrolysis of the following compound?



A) only the starting material itself (no reaction)
B) benzaldehyde and 2,2-dimethyl-1,3-propanediol
C) benzoic acid and 2,2-dimethyl-1,3-propanediol
D) 2-phenyl-1,3-propanediol and acetone

---

42 Base induced elimination of 3-chlorocyclohexanone **I** is much faster than elimination of cyclohexyl chloride **II**.
What is the major factor accounting for this difference?
A) the halogen in **I** is less hindered
B) the halogen in **I** is forced to be axial
C) elimination of **I** produces a more stable conjugated double bond
D) **I** rapidly forms an enolate anion, and this immediately eliminates a stable chloride ion

---

43 Which of the following optically active compounds will be racemized on treatment with warm alcoholic sodium ethoxide?

(R)-2,2,6-trimethylcyclohexanone (R)-2,2,5-trimethylcyclohexanone (R)-2-methyl-2-phenylcyclohexanone (R)-4-methyl-2-cyclohexen-1-one

I **II** **III** **IV**

A) **I** and **II**
B) **I** and **III**
C) **I** and **IV**
D) all compounds will be racemized

---

44 A C_5H_8 hydrocarbon is reacted with BH_3 in THF, followed by oxidation with alkaline hydrogen peroxide.
Treatment of the resulting product with PCC in CH_2Cl_2 produces a chiral ketone, formula C_5H_8O.
What hydrocarbon best fits these facts?
A) 1-methylcyclobutene
B) methylenecyclobutane
C) vinylcyclopropane
D) cyclopentene

---

45 Which of the following compounds would not be a possible product from the mixed aldol reaction of acetaldehyde and butanal?
A) 3-hydroxybutanal
B) 2-ethyl-3-hydroxybutanal

○ C) 3-ethyl-2-hydroxyhexanal
○ D) 3-hydroxyhexanal

---

46 A $C_7H_{12}O_2$ compound gives a positive Tollens' silver mirror test and a positive iodoform test.
Which of the following would satisfy these facts?
○ A) 2-hydroxy-3,3-dimethylcyclopentanone
○ B) 2,5-heptanedione
○ C) 2,2-dimethyl-3-oxopentanal
○ D) 2,2-dimethyl-4-oxopentanal

---

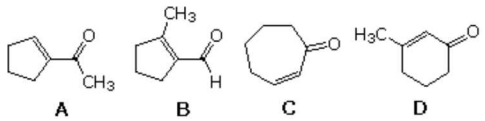
47 The iodoform test for methyl ketones is not widely used anymore.
Which of the following spectroscopic tools is best for providing equivalent information?
○ A) UV-Visible
○ B) ^{1}H nmr
○ C) ^{13}C nmr
○ D) infrared

---

48 An aldol condensation is used to prepare 1,3-diphenyl-2-propenone, $C_6H_5CH{=}CHCOC_6H_5$.
Which combination of reactants will lead to this product?
○ A) enolate donor=acetaldehyde; carbonyl acceptor=benzaldehyde
○ B) enolate donor=phenylacetaldehyde; carbonyl acceptor=phenylacetaldehyde
○ C) enolate donor=acetophenone; carbonyl acceptor=benzaldehyde
○ D) enolate donor=propiophenone; carbonyl acceptor=benzaldehyde

---

49 Which of the following compounds would be the major product from aldol condensation of 6-oxoheptanal?



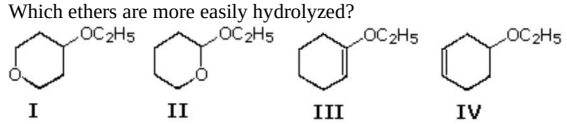
○ ○ ○ ○

---

50 Which of the following procedures **would not** be suitable for preparing 3-methyl-1-phenyl-1-butanone, $C_6H_5COCH_2CH(CH_3)_2$?
○ A) **(i)** $C_6H_5COCH{=}CHCH_3$ + $(CH_3)_2CuLi$ in ether; **(ii)** H_3O^+ workup
○ B) **(i)** benzene + $(CH_3)_2CHCH_2COCl$ & $AlCl_3$ **(ii)** H_3O^+ workup
○ C) **(i)** C_6H_5MgBr + $(CH_3)_2CHCH_2CHO$ in ether; **(ii)** H_3O^+ workup; **(iii)** PCC in CH_2Cl_2
○ D) **(i)** $(CH_3)_2CHMgBr$ + $C_6H_5COCH_3$ in ether; **(ii)** H_3O^+ workup; **(iii)** PCC in CH_2Cl_2

---

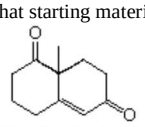
51 Formulas for four ethyl ethers are drawn below. Two are cleaved by aqueous acid much more easily than the other two.
Which ethers are more easily hydrolyzed?



○ A) **I** and **II**
○ B) **II** and **III**
○ C) **III** and **IV**
○ D) **I** and **IV**

---

52 The Wieland-Miescher ketone is an important synthetic intermediate. Its formula is shown below.
What starting materials would be suitable for preparing this compound by a combination of Michael and aldol reactions?


Wieland-Miescher ketone

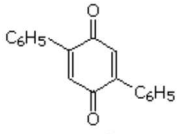
○ A) 4-methyl-2-cyclohexen-1-one and 3-butenal
○ B) 2-methylcyclohexane-1,3-dione and 3-buten-2-one
○ C) 2-methyl-2-vinyl-3-cyclohexen-1-one and acetaldehyde
○ D) 2-methyl-2-cyclohexen-1-one and 1,4-dichlorobutan-2-one

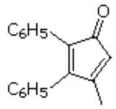
---

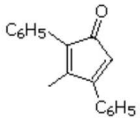
53 2,2-Dimethyl-1,3-propanediol is coveniently prepared by heating 2-methylpropanal with excess formaldehyde and $Ca(OH)_2$.
What sequence of reactions takes place in this synthesis?
○ A) dehydrogenation to 2-methyl-2-propenal followed by addition of formaldehyde
○ B) dehydrogenation to dimethylketene followed by addition of formaldehyde
○ C) a crossed aldol reaction followed by a crossed Cannizzaro reaction
○ D) a crossed Cannizzaro reaction followed by a crossed aldol reaction

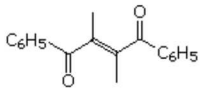
---

54 A bis-aldol dimerization of 1-phenyl-1,2-propanedione, $C_6H_5COCOCH_3$, gives which of the following?


A

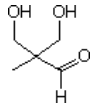

B


C


D

---

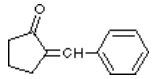
55 What donor and acceptor reactants should be used to prepare the following compound by an aldol reaction?



A) **acceptor** = formaldehyde; **donor** = propanedial
B) **acceptor** = 1,3-propanediol; **donor** = ethanal
C) **acceptor** = propanal; **donor** = formaldehyde
D) **acceptor** = formaldehyde; **donor** = propanal

---

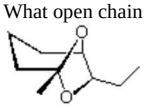
56 What donor and acceptor reactants should be used to prepare the following compound by an aldol condensation (or Claisen-Schmidt reaction)?



A) **acceptor** = cyclopentanone; **donor** = benzaldehyde
B) **acceptor** = benzaldehyde; **donor** = cyclopentanone
C) **acceptor** = phenylacetaldehyde; **donor** = cyclopentanone
D) **acceptor** = cyclopentanecarbaldehyde; **donor** = toluene

---

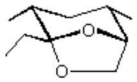
57 The formula of brevicomin, a pheremone of the western pine beetle, is shown below.
What open chain ketodiol would close to this bicyclic acetal? (ignore stereoisomer issues)


brevicomin

A) 7,8-dihydroxynonan-3-one
B) 6,7-dihydroxynonan-3-one
C) 7,8-dihydroxynonan-2-one
D) 6,7-dihydroxynonan-2-one

---

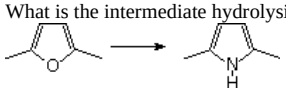
58 The formula of multistriatin, a pheremone of the elm bark beetle, is shown below.
What open chain ketodiol would close to this bicyclic acetal? (ignore stereoisomer issues)


multistriatin

A) 3-ethyl-5-methyl-6,7-dihydroxyheptan-2-one
B) 4,6-dimethyl-7,8-dihydroxyoctan-3-one
C) 4-methyl-7,8-dihydroxynonan-3-one
D) 3-ethyl-6,7-dihydroxyoctan-2-one

---

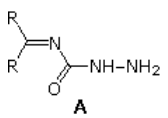
59 A conversion of 2,5-dimethylfuran into 2,5-dimethylpyrrole (see equation) may be accomplished in two steps.
i) hydrolysis of the furan in aqueous acid; **ii)** heating the hydrolysis product with excess ammonium carbonate
What is the intermediate hydrolysis product used in the second step?

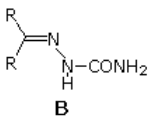


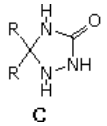
A) 2,5-hexanedione
B) 3,4-hexanedione
C) hexanedial
D) 2,5-dimethylcyclopentanone

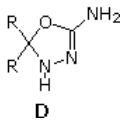
---

60 The reagent semicarbazide, $NH_2CONHNH_2$, reacts with simple aldehydes and ketones ($R_2C{=}O$) forming crystalline derivatives called semicarbazones.
Which of the following represents the structure of a semicarbazone?


A


B


C


D

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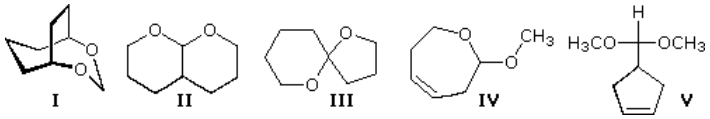
61 Which of the following compounds (I through V) should not be classified as an acetal?



- A) II & III
- B) IV
- C) I
- D) none (they are all acetals)

Check Answers Reset/Clear View Answers

Carboxylic Acids and Derivatives

1. Which of the following is a correct name for $(C_2H_5)_2C{=}C(CH_3)CH_2CO_2H$?

- A) 4,4-diethyl-3-methyl-3-butenoic acid
- B) 4-ethyl-3-methyl-3-hexenoic acid
- C) 3-ethyl-4-methyl-3-hexenoic acid
- D) 3-ethyl-4-methyl-3-hexen-6-oic acid

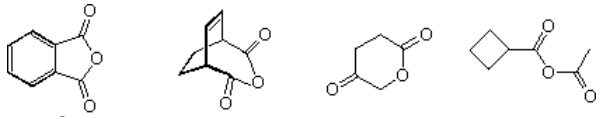
---

2. Which of the following is 2-ethyl-3-formyl-pentanoic acid?

- A) $C_2H_5CH(C_2H_5)CH(CO_2H)CHO$
- B) $(C_2H_5)_2CHCH(CHO)CO_2H$
- C) $C_2H_5CH_2CH(CHO)CO_2C_2H_5$
- D) $C_2H_5CH(CHO)CH(C_2H_5)CO_2H$

---

3 Which of the following compounds **is not** an anhydride?



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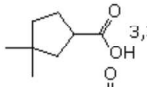
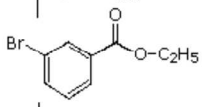
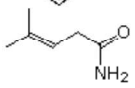
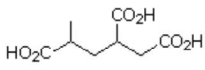
4. Which of the following compounds is not named correctly?

- **A**) isopropyl propanoate $(CH_3)_2CHCO_2C_2H_5$
- **B**) *tert*-butyl acetate $(CH_3)_3COCOCH_3$
- **C**) methyl 2,2-dimethylpropanoate $(CH_3)_3CCO_2CH_3$
- **D**) 2,2-dimethylbutanedioic acid $HO_2CC(CH_3)_2CH_2CO_2H$

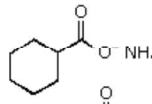
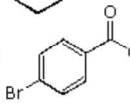
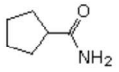
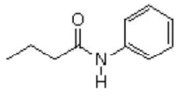
---

5. Which of the following compounds is not named correctly?

- A  3,3-dimethylcyclopentanecarboxylic acid
- B  ethyl meta-bromobenzoate
- C  2-methyl-2-pentenamide
- D  1,2,4-pentanetricarboxylic acid

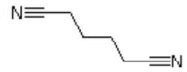
---

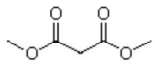
6. Which of the following compounds is not named correctly?

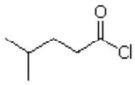
- A  ammonium cyclohexanecarboxylate
- B  isopropyl para-bromobenzoate
- C  cyclopentanecarboxamide
- D  butanoylaniline

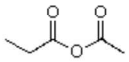
---

7 Which of the following compounds is not named correctly?

○ **A**  hexanedinitrile

○ **B**  methane dimethylcarboxylate

○ **C**  4-methylpentanoyl chloride

○ **D**  acetic propionic anhydride

---

8 Which of the following common names does not represent a dicarboxylic acid?

○ A) lactic acid
○ B) succinic acid
○ C) phthalic acid
○ D) glutaric acid

---

9 Which of the following statements **is not** generally true?

○ A) the boiling point of a carboxylic acid is higher than that of its methyl ester.
○ B) methyl esters are more reactive acylating agents than their amide counterparts.
○ C) amide hydrolysis may be carried out with either strong acid or base catalysis.
○ D) Fischer esterification of acids with alcohols requires a strong base catalyst.

---

10 What is the order of increasing acidity for the following compounds? (weaker < stronger)

I 4-methylpentanoic acid **II** 3-chloropentanoic acid **III** 2-bromopentanoic acid **IV** 2,2-dichloropentanoic acid

○ A) I < II < III < IV
○ B) IV < III < II < I
○ C) I < III < II < IV
○ D) II < III < I < IV

---

11 When comparing the acidity of propanoic acid and pyruvic acid, CH_3COCO_2H, which of the following statements is correct.

○ A) propanoic acid has a lower pK_a and a smaller K_a than pyruvic acid
○ B) propanoic acid has a lower pK_a and a larger K_a than pyruvic acid
○ C) propanoic acid has a higher pK_a and a larger K_a than pyruvic acid
○ D) propanoic acid has a higher pK_a and a smaller K_a than pyruvic acid

---

12 Consider the following dicarboxylic acids?

I adipic acid	**II** malonic acid	**III** oxalic acid	**IV** succinic acid
$HO_2C(CH_2)_4CO_2H$	$CH_2(CO_2H)_2$	$(CO_2H)_2$	$HO_2C(CH_2)_2CO_2H$

What is the order of **increasing acid strength**? (weaker < stronger)

○ A) I < II < III < IV
○ B) IV < III < II < I
○ C) I < IV < II < III
○ D) II < I < IV < III

---

13 Dicarboxylic acids have two pK_a's.

For maleic acid (cis-2-butenedioic acid) these are $pK_a^1 = 2.0$, and $pK_a^2 = 6.3$

For fumaric acid (trans-2-butenedioic acid) these are $pK_a^1 = 3.0$, and $pK_a^2 = 4.5$

Which factor best explains why the cis-isomer has a smaller pK_a^1 and a larger pK_a^2 than the trans-isomer?

○ A) intramolecular steric hindrance
○ B) intramolecular dipole repulsion
○ C) intramolecular hydrogen bonding
○ D) selective solvation in water

---

14 An equimolar mixture of benzoic acid and benzyl alcohol is dissolved in equal volumes of ether and 5% aqueous NaOH. The resulting mixture separates into two immiscible liquid layers. Which of the following is approximately correct?

○ A) both organic solutes are largely in the ether layer
○ B) the benzyl alcohol is in the ether layer and the benzoic acid is in the water layer
○ C) both organic solutes are largely in the water layer
○ D) the benzyl alcohol is in the water layer and the benzoic acid is in the ether layer

---

15 Fischer esterification of phenylacetic acid with 1-propanol gave a mixture of 93% of the ester, propyl phenylacetate, contaminated with 7% unreacted acid. Which of the following treatments would be best used to purify the ester?

- A) reduce the unwanted acid with $LiAlH_4$ in ether.
- B) wash an ether solution of the crude product with concentrated brine (aq. NaCl).
- C) wash an ether solution of the crude product with 5% aqueous sulfuric acid.
- D) wash an ether solution of the crude product with 5% aqueous sodium carbonate.

---

16 Which of the following **would not** be a useful reaction for preparing isobutyric acid, $(CH_3)_2CHCO_2H$?

- A) 2-methyl-1-propanol + Jones' reagent
- B) 2-bromopropane + CO_2; followed by hydrolysis
- C) *cis*-2,5-dimethyl-3-hexene + O_3; followed by H_2O_2
- D) 2-bromopropane + NaCN; followed by acid-catalyzed hydrolysis

---

17 Which of the following **would not** be a useful method for converting a carboxylic acid into an ester derivative?

- A) $RCO_2H + CH_2N_2$ in ether
- B) $RCO_2H + (CH_3)_2C{=}CH_2$ & acid catalyst
- C) $RCO_2H + C_2H_5OH$ & acid catalyst + heat ($-H_2O$)
- D) $RCO_2^{(-)}\ Na^{(+)} + (CH_3)_3CBr$

---

18 Which of the following is an intermediate in the Fischer esterification of propanoic acid with ethanol?

- A) 1-propoxy-1,1-dihydroxyethane
- B) 2-propoxy-1,1-dihydroxyethane
- C) 1-ethoxy-1,1-dihydroxypropane
- D) 2-ethoxy-1,1-dihydroxypropane

---

19 Which of the following reagents **does not react** with benzoic acid, converting it into a different compound?

- A) NaI in acetone
- B) $SOCl_2$
- C) $LiAlH_4$ in ether
- D) excess CH_3Li in pentane

---

20 Which statement regarding isotope exchange of $^{18}OH_2$ with the oxygen of a carboxyl group is correct?

- no exchange occurs under any circumstances
- base-catalyzed exchange is more effective than acid-catalyzed exchange
- acid-catalyzed exchange is more effective than base-catalyzed exchange
- acids and bases are equally effective in catalyzing an exchange

---

21 Which of the following compounds **could not** be converted into pivalic acid (2,2-dimethylpropanoic acid) in three or fewer steps?

- A) 3,3-dimethyl-1-butene
- B) 2,3-dimethyl-2-butene
- C) 2,2-dimethyl-1-propanol
- D) 2-bromo-2-methylpropane

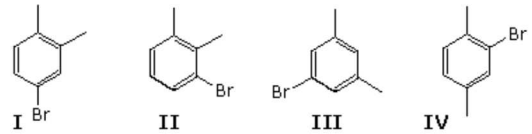
---

22 Treatment of benzoic acid with excess $^{18}OH_2$ and a strong acid catalyst results in what change?

- A) both oxygens of the carboxyl group exchange with the 18O of the water
- B) only the carbonyl oxygen exchanges with the 18O of the water
- C) only the OH oxygen exchanges with the 18O of the water
- D) no change takes place

---

23 Two C_8H_9Br isomers form Grignard reagents which on carboxylation give isomeric carboxylic acids.
Oxidation of each isomeric acid with hot $KMnO_4$ produces the same $C_9H_6O_6$ tricarboxylic acid.
Which of the following compounds are the original isomeric bromides?



- A) I & II
- B) III & IV
- C) I & IV
- D) II & III

---

24 Which of the following reagents will reduce a carboxylic acid to a 1 °-alcohol under mild conditions?

I BH_3 in ether **II** $NaBH_4$ in ethanol **III** H_2 & Pt catalyst **IV** $LiAlH_4$ in ether

- A) I & IV
- B) II & III
- C) only III

○ D) all of them

---

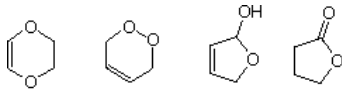
25 What is the order of increasing base strength for the following salts? (weaker < stronger)

I sodium ethoxide **II** potassium formate **III** sodium benzoate **IV** sodium dichloroacetate

○ A) I < II < III < IV
○ B) IV < II < III < I
○ C) II < III < IV < I
○ D) IV < I < II < III

---

26 Reduction of 4-oxobutyric acid, also called succinic semialdehyde, by sodium borohydride followed by aqueous acid gives a $C_4H_6O_2$ product.
This product is which of the following compounds?



A ○ B ○ C ○ D ○

---

27 Which compound **does not react** with ammonia to form propanamide under mild conditions?
○ A) propanoic acid
○ B) propanoyl chloride
○ C) ethyl propanoate
○ D) propanoic anhydride

---

28 Which sequence of reactions would be best for the conversion of toluene into *para*-bromophenylacetic acid.? (NBS = N-bromosuccinimide)
○ A) **i)** Br_2 & $FeBr_3$; **ii)** $KMnO_4$ & heat; **iii)** NaCN in ethanol; **iv)** $H_3O^{(+)}$ & heat
○ B) **i)** Br_2 & $FeBr_3$; **ii)** NBS in CCl_4; **iii)** Mg in ether followed by CO_2; **iv)** $H_3O^{(+)}$
○ C) **i)** Br_2 & $FeBr_3$; **ii)** NBS in CCl_4; **iii)** NaCN in ethanol; **iv)** $H_3O^{(+)}$ & heat
○ D) **i)** Br_2 & $FeBr_3$; **ii)** $KMnO_4$ & heat; **iii)** Mg in ether followed by CO_2; **iv)** $H_3O^{(+)}$

---

29 On heating in the presence of bromine, 2,2-dimethyl-3-oxobutyric acid produces 3-bromo-3-methyl-2-butanone.
What unstable intermediate is involved in this reaction?
○ A) 1,2,2-trimethylcyclopropanol
○ B) 2,2-dimethyl β butyrolactone
○ C) 2-hydroxy-3-methylbutene
○ D) dimethylketene

---

30 Fischer esterification of mesitoic acid (2,4,6-trimethylbenzoic acid) is extremely slow compared with benzoic acid itself.
What is the major factor accounting for this difference in reactivity?
○ A) steric hindrance by the ortho methyl groups.
○ B) the electron donating inductive effect of the methyl substituents.
○ C) acid-catalyzed rearrangement of the methyl substituents.
○ D) rapid acid-catalyzed decarboxylation of mesitoic acid.

---

31 Which of the following reagents would be best for reducing an ester to an aldehyde?
○ A) $LiAlH_4$ in ether
○ B) B_2H_6 in ether
○ C) $NaBH_4$ in aqueous ethanol
○ D) diisobutylaluminum hydride (DIBAH) in toluene at -78 ºC

---

32 Which of the following reagents are suitable for reducing an amide to an aldehyde?

I $LiAlH_4$ in ether	**II** diisobutylaluminum hydride (DIBAH) in toluene at -78 ºC
III $LiAlH(t\text{-}C_4H_9O)_3$ in ether at -78 ºC	**IV** $NaBH_4$ in aqueous ethanol

○ A) I & IV
○ B) II & III
○ C) only I
○ D) all but III are suitable

---

33 Which of the following reagents are suitable for reducing an acyl chloride to an aldehyde?

I $LiAlH_4$ in ether	**II** $NaBH_4$ in *tert*-butanol
III $LiAlH(t\text{-}C_4H_9O)_3$ in ether at -78 ºC	**IV** H_2 and $Pd/BaSO_4$ catalyst

○ A) III & IV
○ B) I & IV
○ C) only I

○ D) all are suitable

---

34 Which of the following methods would **not be useful** for preparing ketones?

I Friedel-Crafts reaction of an acyl chloride with benzene ($AlCl_3$ catalysis)

II reaction of R_2CuLi with an acyl chloride in ether at low temperature.

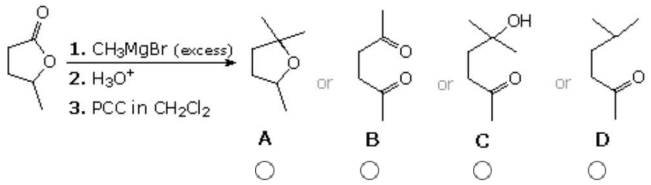
III reaction of Grignard reagents with nitriles, followed by hydrolysis

IV reaction of methyllithium with the lithium salt of a carboxylic acid, followed by hydrolysis

○ A) II & IV
○ B) II & III
○ C) only III
○ D) none (all are useful)

---

35 What is the expected product from the double reaction drawn below?



○ ○ ○ ○

---

36 Which of the following reactions is most likely to produce ethyl propanoate?

○ A) sodium ethoxide + propanoic acid
○ B) propanol + acetyl chloride
○ C) sodium propanoate + acetic anhydride
○ D) potassium propanoate + ethyl iodide

---

37 If diethyl amine is treated separately with the following derivatives of isobutyric acid, what order of reactivity is expected?
greater reactivity > lesser reactivity

I isobutyronitrile (2-methylpropanenitrile)	**II** isobutyryl chloride (2-methylpropanoly chloride)	**III** ethyl isobutyrate	**IV** isobutyric anhydride (2-methylpropanoic anhydride)

○ A) I > II > III > IV
○ B) II > IV > III > I
○ C) IV > II > III > I.
○ D) IV > III > II > I

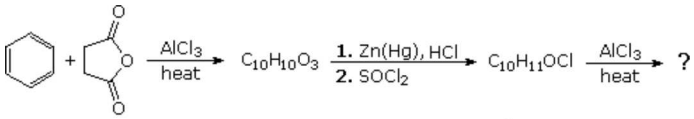
---

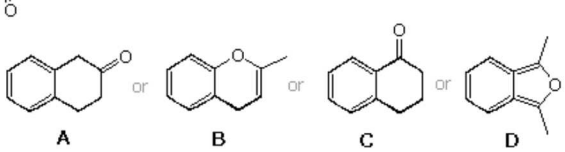
38 Methyl esters of carboxylic acids, RCO_2CH_3, have somewhat higher molecular masses than 1 °-amide, $RCONH_2$, derivatives of the same acid. However, the amides have much higher boiling points. What is responsible for this difference?

○ A) hydrogen bonding molecular association.
○ B) resonance conjugation of N with C=O
○ C) the lower electronegativity of N versus O
○ D) rapid pyramidal inversion of the nitrogen

---

39 What is the expected product from the reaction sequence drawn below?





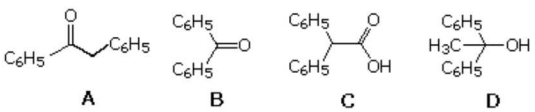
○ ○ ○ ○

---

40 Ethyl acetate undergoes the following sequence of reactions:

1. treatment with excess phenylmagnesium bromide in ether
2. heating with conc. H_3PO_4
3. treatment B_2H_6 in ether, followed by alkaline H_2O_2
4. treatment with Jones' reagent (CrO_3 in aqueous acid + acetone)

Which of the following is the expected product? note that C_6H_5 = phenyl



○ ○ ○ ○

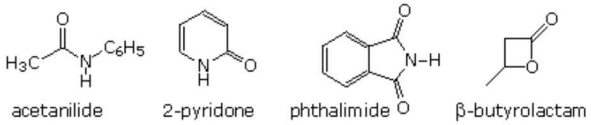
---

41 The C–NH_2 bond in acetamide is 0.1 Å shorter than the C–NH_2 bond in ethylamine. Why?

- A) N:H repulsion in ethylamine
- B) hyperconjugation in ethylamine
- C) dipole interactions in acetamide
- D) p-π resonance in acetamide

---

42 Which of the following is not named correctly?



acetanilide (A) | 2-pyridone (B) | phthalimide (C) | β-butyrolactam (D)

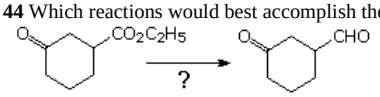
---

43 Methyl butyrate is reacted with excess ammonia, and the product is then treated with bromine in aqueous NaOH. What is the expected product?

- A) butylamine
- B) pentylamine
- C) propylamine
- D) N-bromobutyramide

---

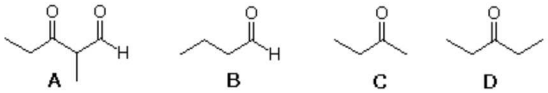
44 Which reactions would best accomplish the following transformation?



- A) **1.** $LiAlH_4$; **2.** Jones' reagent
- B) **1.** $LiAlH_4$; **2.** PCC in CH_2Cl_2
- C) **1.** $NaBH_4$; **2.** Jones' reagent
- D) **1.** $NaBH_4$; **2.** PCC in CH_2Cl_2

---

45 Ethyl propanoate is added to an ethanol soution of sodium ethoxide and heated to reflux for several hours.
The product was then refluxed in 5% HCl for several more hours, and extracted with ether
What compound has been prepared by this procedure?



A | B | C | D

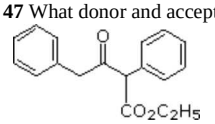
---

46 Adipic acid is converted to its diacid chloride by reaction with $SOCl_2$, and this then reacts with 2 equivalents of sodium azide in ether solution.
Addition of conc. HCl, followed by heating, results in considerable gas evolution and the formation of a crystalline water soluble solid.
What is this product? **Hint:** addition of aq. NaOH to the solid produces a foul smelling liquid.

- A) 1,4-diaminobutane, dihydrochloride salt
- B) 1,5-diaminopentane, dihydrochloride salt
- C) 1,6-diaminohexane, dihydrochloride salt
- D) diammonium adipate

---

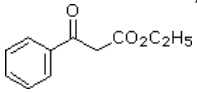
47 What donor and acceptor reactants should be used to prepare the following compound by a Claisen condensation?



- A) **acceptor** = ethyl benzoate; **donor** = ethyl phenylacetate
- B) **acceptor** = ethyl phenylacetate; **donor** = ethyl benzoate
- C) **acceptor** = ethyl benzoate; **donor** = ethyl benzoate
- D) **acceptor** = ethyl phenylacetate; **donor** = ethyl phenylacetate

---

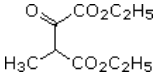
48 What donor and acceptor reactants should be used to prepare the following compound by a Claisen condensation?



- A) **acceptor** = ethyl benzoate; **donor** = ethyl acetate
- B) **acceptor** = ethyl acetate; **donor** = ethyl benzoate
- C) **acceptor** = ethyl benzoate; **donor** = ethyl benzoate
- D) **acceptor** = ethyl acetate; **donor** = ethyl acetate

---

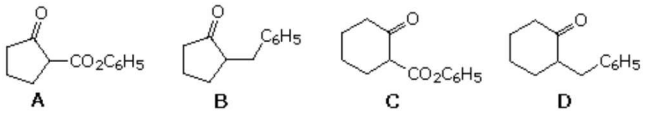
49 What donor and acceptor reactants should be used to prepare the following compound by a Claisen condensation?



- A) **acceptor** = ethyl propanoate; **donor** = diethyl oxylate
- B) **acceptor** = diethyl oxylate; **donor** = ethyl propanoate
- C) **acceptor** = diethyl carbonate; **donor** = ethyl propanoate
- D) **acceptor** = ethyl propanoate; **donor** = diethyl carbonate

---

50 A Dieckmann condensation of diethyl adipate was carried out by heating with sodium ethoxide.
One equivalent of benzyl bromide was added, and the resulting mixture was then refluxed in 5% HCl for several hours, and extracted with ether.
What compound has been prepared by this procedure?



---

51 2,2-Dimethyl-1,3-cyclohexanedione is refluxed several hours in an aqueous dioxane solution of sodium hydroxide (10%).
The resulting solution is adjusted to pH=5 by addition of dilute HCl and then extracted with ether.
What compound has been prepared by this procedure?

- A) 2-cyclohexenone
- B) 5-oxohexanoic acid
- C) 6-methylheptanoic acid
- D) 5-oxo-6-methylheptanoic acid

---

52 The malonic ester synthesis is useful for preparing substituted acetic acids.
Which of the following **would not** be easily prepared by this method?

I phenylacetic acid **II** 3-phenylpropanoic acid **III** 2,2-dimethylpropanoic acid **IV** 4-pentenoic acid

- A) IV
- B) II & IV
- C) I & III
- D) all but I

---

53 Which set of reaction conditions is best suited for the preparation of 2,2-dimethylpropanoic acid from 2-bromo-2-methylpropane?

- A) **1.** NaCN in ethanol; **2.** $H_3O^{(+)}$ & heat
- B) **1.** NaC≡CH in ether; **2.** aqueous $KMnO_4$ & heat
- C) **1.** Mg in ether; **2.** CO_2, then $H_3O^{(+)}$
- D) **1.** Mg in ether; **2.** CH_3CHO; **3.** Jones' reagent

---

54 Which set of reaction conditions is best suited for the preparation of 5-oxo-hexanoic acid from 5-bromo-2-pentanone?

- A) **1.** NaCN in ethanol; **2.** $H_3O^{(+)}$ & heat
- B) **1.** NaC≡CH in ether; **2.** aqueous $KMnO_4$ & heat
- C) **1.** Mg in ether; **2.** CO_2, then $H_3O^{(+)}$
- D) **1.** NaOH in ethanol; **2.** Jones' reagent

---

55 Which of the following is most readily decarboxylated on heating?

- A) sodium 4-oxopentanoate
- B) succinic acid
- C) phthalic acid
- D) 4-methyl-3-pentenoic acid

---

56 Which one of the following compounds would react with C_2H_5MgBr to make 3-pentanol ?

- A) ethanal
- B) ethyl formate
- C) acetic acid
- D) acetone

---

57 The acetoacetic ester synthesis is useful for preparing methyl ketones.
Which of the following **would not** be easily prepared by this method?

I acetylcyclopentane **II** acetophenone **III** 3-ethyl-2-pentanone **IV** 3-methyl-4-phenyl-2-butanone

- A) I & II
- B) III & IV
- C) only I
- D) only II

---

58 Devise a series of reactions to convert ethyl 3-oxobutyrate to ethyl 4-oxopentanoate.
Select reagents and conditions from the following table, listing them in the order of use.

1 sodium ethoxide	**2** ethanol +	**3** $H_3O^{(+)}$	**4** CO_2 then	**5** Mg in ether

in ethanol	acid catalyst & heat	heat	$H_3O^{(+)}$	
6 PBr_3	**7** $NaBH_4$ in alcohol	**8** CH_2I_2 in ether Zn(Cu)	**9** $BrCH_2CO_2C_2H_5$	**10** $(CH_3CO)_2O$ + pyridine

- A) **1** then **9** then **3** then **2**
- B) **7** then **6** then **5** then **10** then **2**
- C) **3** then **7** then **6** then **5** then **10** then **2**
- D) **8** then **3** then **2**

---

59 A C_7H_9N base reacts with sodium nitrite and hydrochloric acid at 0 ºC, giving a clear solution.
On heating with KCN and $Cu_2(CN)_2$ a gas evolves, and continued heating with conc. HCl yields a $C_8H_8O_2$ crystalline acid.
Heating this acid with aqueous $KMnO_4$ produces a $C_8H_6O_4$ product, which dehydrates on strong heating to give a crystalline $C_8H_4O_3$ compound.
What is the C_7H_9N base?

- A) benzylamine
- B) N-methylaniline
- C) *para*-toluidine (the toluidines are aminotoluenes)
- D) *ortho*-toluidine

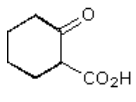
---

60 Heating diethyl malonate with 2 equivalents of ethyl acrylate and 1.2 equivalents of sodium ethoxide, followed by neutralization of the base, produces a $C_{15}H_{22}O_7$ compound.
Heating this compound in 10%H_4SO_4 yields a $C_7H_{10}O_3$ crystalline carboxylic acid.
What is this product?

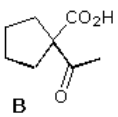
- A) 2-oxocyclohexane-1-carboxylic acid
- B) 3-oxocyclohexane-1-carboxylic acid
- C) 4-oxocyclohexane-1-carboxylic acid
- D) 3-(2-oxocyclobutyl)propanoic acid

---

61 Which of the following acids does not decarboxylate on heating?



A



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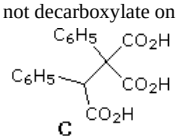
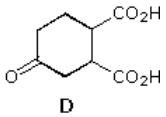


C



D

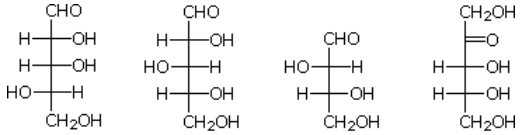
Check Answers | Reset/Clear | View Answers

Biologically Important Compounds

Carbohydrates

---

1 Which of the following is a D-aldopentose?



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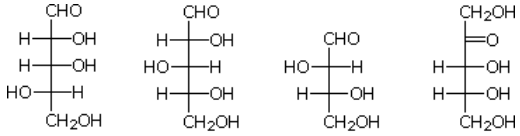
2. Which of the following is an L-saccharide?



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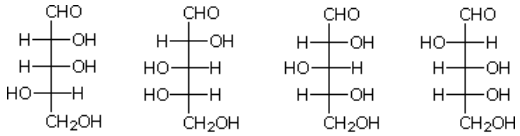
3 (+)-Arabinose is (2R, 3S, 4S)-aldopentose. Which of the following is (+)-arabinose?



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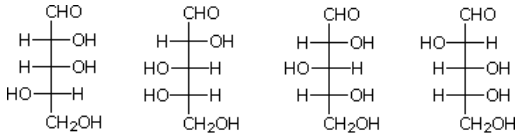
4 Which of the following gives an optically inactive aldaric acid on oxidation with dilute nitric acid?



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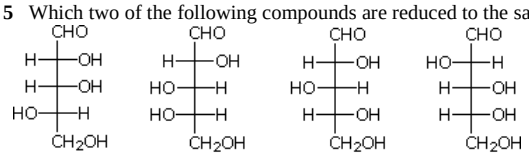
5 Which two of the following compounds are reduced to the same chiral alditol by sodium borohydride?



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

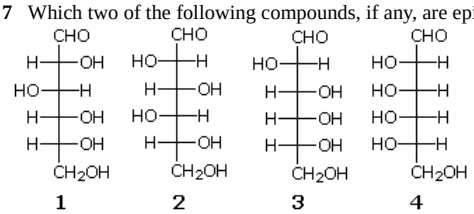
---

6 Which of the following statements is correct?

- A) The Ruff procedure lengthens an aldose chain and gives a single product.
- B) The Ruff procedure shortens an aldose chain and gives two epimers.
- C) The Kiliani-Fischer procedure shortens an aldose chain and gives a single product.
- D) The Kiliani-Fischer procedure lengthens an aldose chain and gives two epimers.

---

7 Which two of the following compounds, if any, are epimers?



- A) 1 & 4
- B) 1 & 3
- C) 2 & 3

○ D) 3 & 4

---

8 Which of the following **is not** a disaccharide?

○ A) sucrose
○ B) mannose
○ C) lactose
○ D) maltose

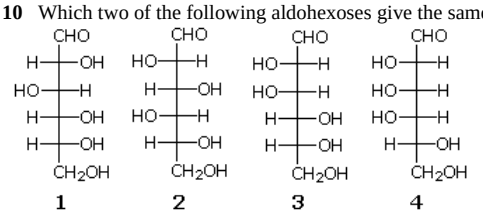
---

9 Which of the following **is not** a reducing sugar?

○ A) sucrose
○ B) mannose
○ C) lactose
○ D) fructose

---

10 Which two of the following aldohexoses give the same osazone derivative?



○ A) 1 & 4
○ B) 1 & 3
○ C) 2 & 3
○ D) 3 & 4

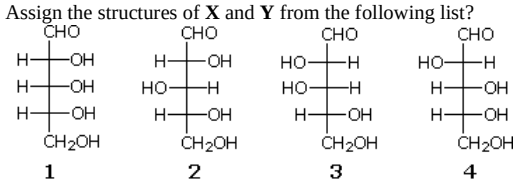
---

11 Which statement about the pyranose form of mannose **is not** correct?

○ A) it exists as two anomeric stereoisomers.
○ B) it reacts with Tollens' reagent to give a silver mirror. (i.e. it is a reducing sugars)
○ C) reaction with excess CH_3I and AgOH gives a non-reducing penta-O-methyl derivative.
○ D) it resists reduction with aqueous sodium borohydride.

---

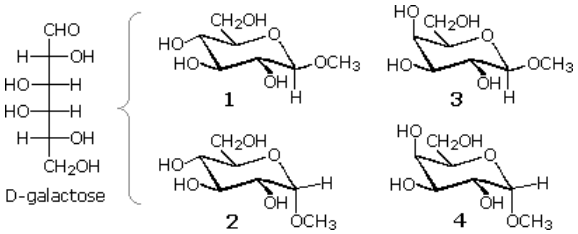
12 Two aldopentoses **X** and **Y** give the same osazone derivative.
X is oxidized to an optically active aldaric acid by dilute nitric acid.
Ruff degradation of **Y** gave a tetrose which was similarly oxidized to an optically active aldaric acid
Assign the structures of **X** and **Y** from the following list?



○ A) X=1 & Y=4
○ B) X=4 & Y=1
○ C) X=2 & Y=3
○ D) X=3 & Y=2

---

13 Which of the structures **1** through **4** is methyl α-D-galactopyranoside?



A **1** B **2** C **3** D **4**
○ ○ ○ ○

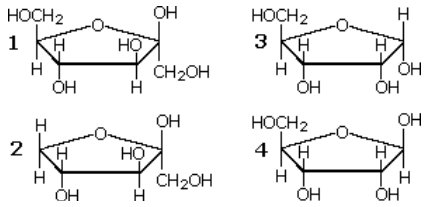
---

14 What is invert sugar, and why is it so named?

○ A) the sugar mixture from hydrolysis of sucrose; fructose is isomerized to glucose.
○ B) the sugar mixture from hydrolysis of sucrose; the optical rotation changes from (+) to (-).
○ C) the sugar mixture from hydrolysis of starch; α-glycosidic bonds are changed to β-glycosidic bonds.
○ D) the sugar mixture from hydrolysis of starch; glucose is isomerized to fructose.

---

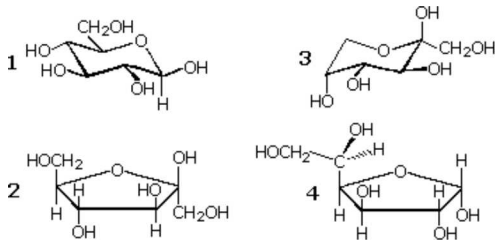
15 Which of the following compounds is a β-aldopentafuranose?



A **1** B **2** C **3** D **4**

---

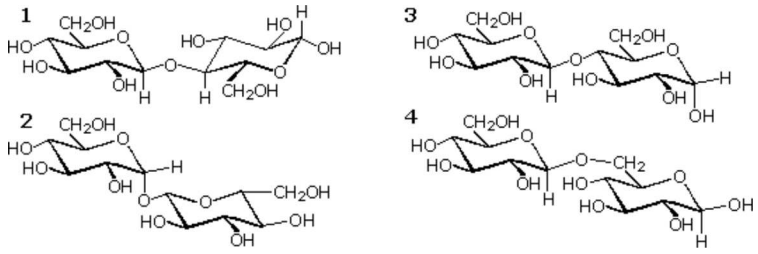
16 Which of the following compounds is a β-ketohexafuranose?



A **1** B **2** C **3** D **4**

---

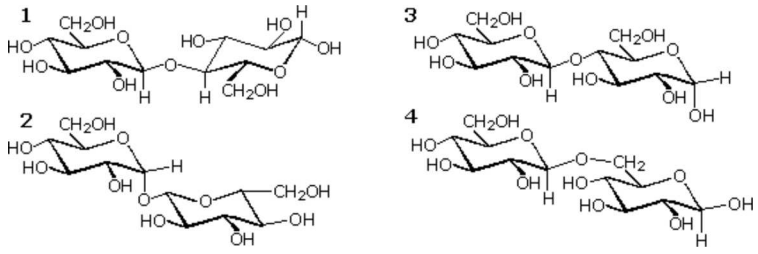
17 Which of the following disaccharides is the α-anomer of 4-O-(β-D-glucopyranosyl)-D-glucopyranose?



A **1** B **2** C **3** D **4**

---

18 Which of the following disaccharides is a nonreducing sugar (does not react with Tollens' reagent)?



A **1** B **2** C **3** D **4**

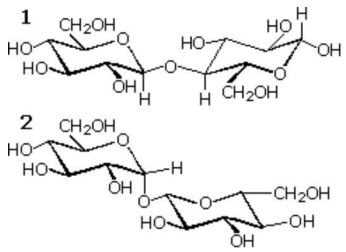
---

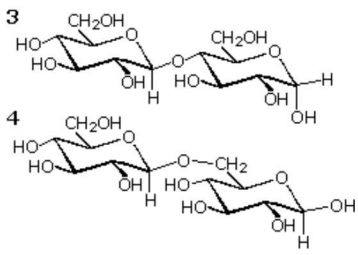
19 Which of the following best describes the polysaccharide amylose?

- A) a 1,4-O-α-linked poly-D-glucose
- B) a 1,4-O-β-linked poly-D-glucose
- C) an alternating 1,4-O-α/β-linked poly-D-glucose
- D) a 1,4-O-α-linked poly-D-mannose

---

20 Which of the following disaccharides is the β-anomer of 4-O-(β-D-glucopyranosyl)-D-glucopyranose?





A **1** B **2** C **3** D **4**

---

21 Which of the following best describes the polysaccharide cellulose?

A) a 1,4-O-α-linked poly-D-galactose
B) a 1,4-O-β-linked poly-D-galactose
C) a 1,4-O-α-linked poly-D-glucose
D) a 1,4-O-β-linked poly-D-glucose

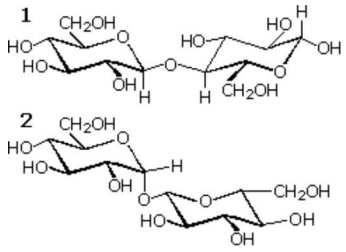
---

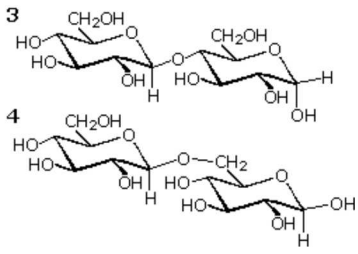
22 When octa-O-methyl D-cellobiose is hydrolyzed by aqueous acid, two O-methyated glucose derivatives are formed.
One is a tetramethyl derivative, and the other is a trimethyl derivative.
Why is a single methyl substituent lost in this process?

A) one methoxy group is lost by β-elimination.
B) one methoxy group is an ester and the others are all ethers.
C) one methoxy group is part of an acetal, the others are all ethers.
D) one glucose is an α-methyl glycoside; the other is a β-methyl glycoside.

---

23 Gentiobiose ($C_{12}H_{22}O_{11}$) is a reducing sugar. It forms an osazone derivative and mutarotates.
Hydrolysis of gentiobiose by the enzyme emulsin produces D-glucose as the only product.
An octamethyl derivative of gentiobiose is hydrolyzed to a mixture of 2,3,4,6-tetra-O-methylglucose and 2,3,4-tri-O-methylglucose.
What is the structure of gentiobiose (either anomer)?

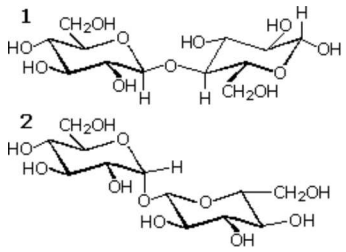


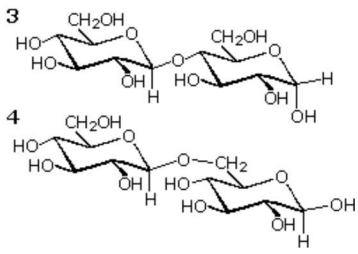


A **1** B **2** C **3** D **4**

---

24 Trehalose ($C_{12}H_{22}O_{11}$) is a non-reducing sugar. Hydrolysis by the enzyme maltase produces D-glucose as the only product.
An octamethyl derivative of trehalose is hydrolyzed to 2,3,4,6-tetra-O-methylglucose as the only product.
What is the structure of trehalose?





A **1** B **2** C **3** D **4**

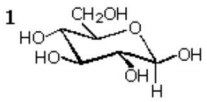
---

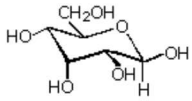
25 Acid-catalyzed reaction of D-glucose with benzaldehyde produces the 4,6-O-benzylidene derivative.
Reduction with $NaBH_4$, followed by excess HIO_4 cleavage and acid hydrolysis yields a $C_4H_8O_4$ tetrose and benzaldehyde.
What is the configuration of this tetrose?

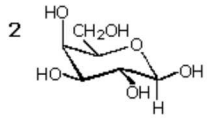
A) 2S, 3S
B) 2R, 3S
C) 2R, 3R
D) 2S, 3R

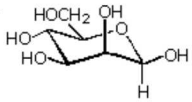
---

26 A D-aldohexose gives an optically inactive aldaric acid on oxidation with nitric acid.
Ruff degradation of this aldohexose produces an aldopentose that is reduced by $NaBH_4$ to an optically active alditol.
Which of the following is this hexose?

1 

3 

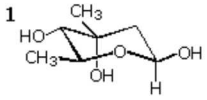
2 

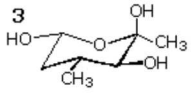
4 

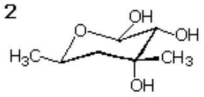
A **1** B **2** C **3** D **4**

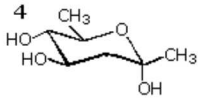
---

27 Mycarose is a rare $C_7H_{14}O_4$ sugar found in some antibiotic natural products.
Mycarose gives a positive Tollens' test, does not form an osazone derivative, and on exhaustive HIO_4 oxidation gives HCO_2H, CH_3CHO and CH_3COCH_2CHO.
Which of the following structures might be mycarose?

1 

3 

2 

4 

A **1** B **2** C **3** D **4**

---

28 If two isomers have been classified correctly as **anomers**, they may also be called...?

- A) conformers
- B) enantiomers
- C) tautomers
- D) diastereomers

Amino acids and Proteins

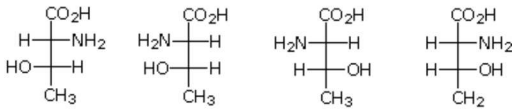
---

29 Both cysteine and methionine are chiral L-amino acids that incorporate a single sulfur. The C-2 configuration is S in methionine, but R in cysteine. Why?

- A) biosynthesis of cysteine proceeds by inversion at C-2.
- B) the sulfur in cysteine prevents zwitterion formation.
- C) the sulfur atom in methionine is remote from C-2 and does not influence the sequence rule.
- D) the sulfur atom in cysteine is remote from C-2 and does not influence the sequence rule.

---

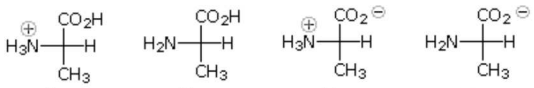
30 Threonine is (2S,3R)-2-amino-3-hydroxybutanoic acid.
Which of the following is threonine?



A B C D

---

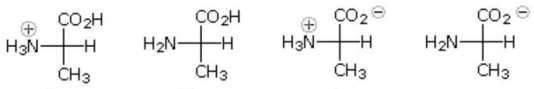
31 Which of the following is the major solute species in a solution of alanine at pH=2?



A B C D

---

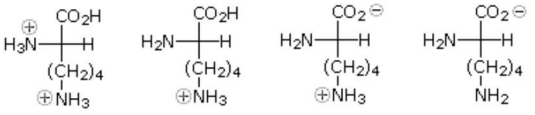
32 Which of the following is the major solute species in a solution of alanine at pH=6?



A B C D

---

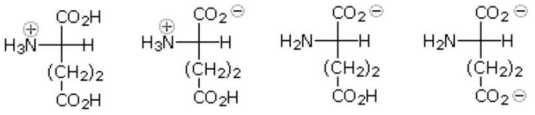
33 Which of the following is the major solute species in a solution of lysine at pH=10.8?



A ○ B ○ C ○ D ○

---

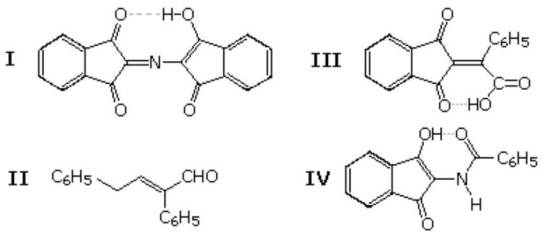
34 Which of the following is the major solute species in a solution of glutamic acid at pH=4.0?



A ○ B ○ C ○ D ○

---

35 Ninhydrin reagent reacts with α-amino acids to give a purple color.
In the the reaction of ninhydrin with phenylalanine, which of the following is responsible for this color?



A **1** ○ B **2** ○ C **3** ○ D **4** ○

---

36 Which of the following statements most correctly defines the isoelectric point?

○ A) the pH at which all molecular species are ionized and that carry the same charge.
○ B) the pH at which all molecular species are neutral and uncharged.
○ C) the pH at which half the molecular species are ionized (charged) and the other half unionized.
○ D) the pH at which negatively and positively charged molecular species are present in equal concentration.

---

37 A tripeptide is composed equally of L-valine, L-tyrosine and L-alanine (one molecule of each).
How many isomeric tripeptides of this kind may exist?

○ A) three
○ B) four
○ C) six
○ D) eight

---

38 Peptides are composed of amino acids joined by amide bonds.
Which of the following statements **is not** correct?

○ A) amide groups are more resistant to hydrolysis than are similar ester groups.
○ B) p-π resonance stabilizes the amide bond.
○ C) stable conformations of peptides are restricted to those having planar amide groups.
○ D) amide groups do not participate in hydrogen bonding interactions.

---

39 The Strecker synthesis of α-amino acids begins with the reaction of an aldehyde with ammonium chloride and potassium cyanide.
This is followed by an acid-catalyzed hydrolysis, that gives the amino acid.
What functional group is hydrolyzed in the second step?

○ A) an ester
○ B) an nitrile
○ C) an amide
○ D) an imine derivative

---

40 The methyl and ethyl esters of many amino acids are sold commercially as their hydrochloride salts.
Why are these derivatives not sold in the form of the neutral amino esters?

○ A) the salts are solids, whereas many amino esters are liquids and are difficult to package.
○ B) rearrangement to the N-alkylamino acid takes place.
○ C) polymerization takes place by acylation of amine groups by an ester.
○ D) an extra step in their preparation would be required.

---

41 You have a mixture of three amino acids: E (pI=3.2), Y (pI=5.7) & K (pI=9.7)
Under electrophoresis at pH=7.7, in which direction will each component of the mixture move?

○ A) E to anode; Y & K to cathode

B) E to anode; Y stationary; K to cathode
C) E to cathode; Y stationary; K to anode
D) E & Y to anode; K to cathode

---

42 Sanger's reagent, 2,4-dinitrofluorobenzene, reacts with which functional groups in a peptide?
A) free amino groups
B) the phenolic hydroxyl group in tyrosine
C) the aromatic heterocyclic rings of histidine and tryptophan
D) the sulfide group of methionine

---

43 All the common amino acids, save one, react with cold nitrous acid (HNO_2) and evolve nitrogen gas.
Which of the following amino acids is that compound?
A) cysteine
B) proline
C) histidine
D) arginine

---

44 The amino acid cysteine often forms a disulfide bond with another nearby cysteine.
How is this reaction best classified?
A) an addition
B) a substitution
C) an oxidation
D) a reduction

---

45 A hexapeptide has the composition Ala,Gly,Phe,Val_3. Both the N-terminal and C-terminal units are Val.
Cleavage of the hexapeptide by chymotrypsin gives two different tripeptides, both having Val as the N-terminal group.
Among the products of random hydrolysis is a Ala-Val dipeptide fragment. What is the primary structure of the hexapeptide?
A) Val-Gly-Phe-Val-Ala-Val
B) Val-Ala-Phe-Val-Gly-Val
C) Val-Gly-Ala-Val-Phe-Val
D) Val-Phe-Val-Ala-Gly-Val

---

46 An octapeptide has the composition Ala_2,Gly_2,Phe_2,Ser_2. The N-terminal unit is Ala.
Cleavage of the octapeptide by chymotrypsin gives a single tetrapeptide, having Ala as its N-terminal group.
Among the products of random hydrolysis is a Phe-Ala-Gly tripeptide fragment. What is the primary structure of the octapeptide?
A) Ala-Gly-Ser-Phe-Phe-Ser-Gly-Ala
B) Ala-Ser-Gly-Phe-Ala-Gly-Ser-Phe
C) Ala-Ser-Gly-Phe-Ala-Ser-Gly-Phe
D) Ala-Gly-Ser-Phe-Ala-Gly-Ser-Phe

---

47 Peptide bond formation from protected amino acid reactants is often carried out with which reagent?
A) p-toluenesulfonyl chloride
B) di-t-butyl dicarbonate
C) dicyclohexylcarbodiimide
D) benzyl chloroformate

---

48 What reagent is used in the Edman degradation for N-terminal group analysis of peptides?
A) phenyl isothiocyanate
B) di-t-butyl dicarbonate
C) dicyclohexylcarbodiimide
D) benzyl chloroformate

---

49 Which of the following methods selectively cleaves a peptide at methionine residues?
A) trypsin digestion.
B) cyanogen bromide.
C) chymotrypsin digestion.
D) Edman degradation.

---

50 Which of the following **is not** an important secondary structural feature in large peptides and proteins?
A) the α-helix.
B) the β-turn.
C) chair conformations.
D) the β-pleated sheet.

---

51 Which of the following statements is true for phenylalanine in an aqueous solution at pH = pI?
A) the nonpolar, neutral species $C_6H_5CH_2CH(NH_2)CO_2H$ is the most abundant solute.
B) the concentrations of [+] and [-] charged molecular ions are equal.

C) racemization is rapid.
D) this condition is impossible, since pH can never equal pI.

---

52 Which of the following factors has the **least influence** on the secondary and tertiary structures of proteins?
A) the achiral nature of glycine units.
B) steric hindrance of bulky side-chains on the peptide backbone.
C) hydrogen bonding of C=O to N-H groups located near each other in space.
D) conformational restriction imposed by proline units.

---

53 From the reagents in the following table, select the one best used to cleave peptide chains at Arg and Lys residues.

1	**2**	**3**	**4**	**5**
ninhydrin	cyanogen bromide	trypsin	chymotrypsin	phenyl isothiocyanate

A **5** B **4** C **3** D **2**

---

54 From the reagents in the following table, select the one used in a color test for amino acids.

1	**2**	**3**	**4**	**5**
ninhydrin	cyanogen bromide	trypsin	chymotrypsin	phenyl isothiocyanate

A **1** B **2** C **3** D **4**

Lipids

---

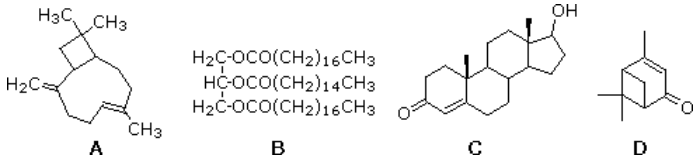
55 Fatty acids are important components of many lipids. For which of the following lipid classes or lipid derivatives are fatty acids **not a significant component**?
A) phospholipids
B) triglycerides
C) waxes
D) steroids

---

56 Which of the following is a general characteristic of those natural products classified as lipids?
A) they are generally insoluble in water and soluble in organic solvents.
B) they are generally soluble in water and insoluble in organic solvents.
C) they have the common structural feature of two or more fused carbon rings.
D) they generally have a high weight proportion of oxygen (>40%).

---

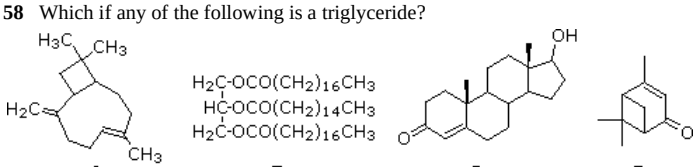
57 Which of the following would be classified as a sesquiterpene?



A B C D

---

58 Which if any of the following is a triglyceride?



A B C D

---

59 Which of the following statements about glyceryl tripalmitate, 1,2,3-propanetriol tris(hexadecanoate), **is not** true?
A) it is reduced to 1-hexadecanol by lithium aluminum hydride
B) it is achiral
C) it has a higher melting point than glyceryl trioleate
D) it adds bromine

---

60 Counting both constitutional and stereoisomers, how many isomeric triglycerides incorporating one oleic acid and two stearic acid groups exist?
A) one (there are no isomers)
B) two
C) three
D) four

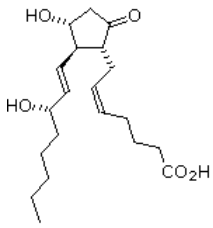
---

61 Which statement comparing the soap. sodium stearate, and the detergent sodium lauryl sulfate **is not** true?

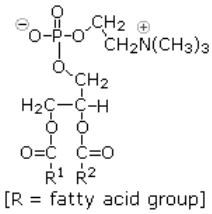
- A) both form micelles in water dispersion.
- B) at pH below 6.5 the soap precipitates, the detergent does not.
- C) the soap is less alkaline (basic) than the detergent.
- D) calcium salts of the soap are relatively insoluble.

---

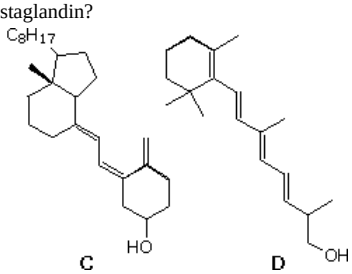
62 Which of the following would be classified as a prostaglandin?



A



B

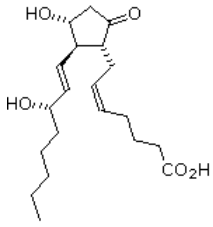


C

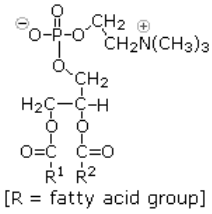
D

---

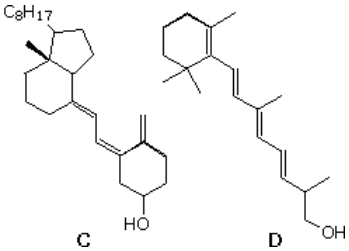
63 Which of the following is vitamin A?



A



B



C

D

---

64 Spermaceti, $C_{32}H_{64}O_2$, is a substance found in the head of the sperm whale. It displays a strong infrared absorption at 1735 cm^{-1}

$LiAlH_4$ reduction of spermaceti gives a single $C_{16}H_{34}O$ alcohol

What class of lipids does spermaceti belong?

- A) triglycerides
- B) waxes
- C) terpenes
- D) trans-fatty acids

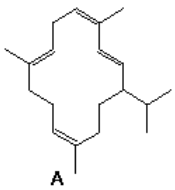
---

65 Cembrene, a $C_{20}H_{32}$ hydrocarbon, has a UV λ_{max}=240 nm.

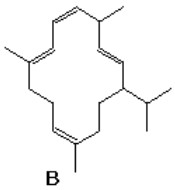
Exhaustive addition of hydrogen (Pd catalyst) gives 4-isopropyl-1,7,11-trimethylcyclotetradecane.

Ozonolysis of cembrene with a Zn dust workup yields eqimolar amounts of $CH_3COCH_2CH_2CHO$, CH_3COCHO, $CH_3COCH_2CH_2CH[CH(CH_3)_3]CHO$ & $CH_2(CHO)_2$

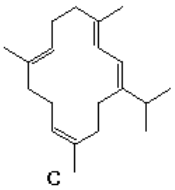
Which of the following is a plausible structure for cembrene (double bond configurations are not specified)?



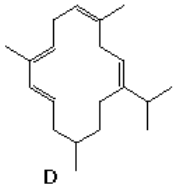
A



B



C



D

Nucleic Acids

---

66 Which of the following is not a common component of both DNA and RNA?

- A) ribose
- B) phosphate
- C) cytosine
- D) adenine

---

67 Which of the following is not a component of RNA?

- A) adenine
- B) phosphate
- C) cytosine
- D) thymine

---

68 Which of the following is purine base?

- A) guanine
- B) indole

C) cytosine
D) thymine

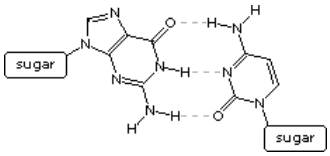
---

69 Which of the following is a pyrimidine base?
A) imidazole
B) guanine
C) cytosine
D) adenine

---

70 The H-bonded base pair shown on the right represents which of the following?

A) adenine-thymine
B) guanine-cytosine
C) adenine-cytosine
D) adenine-guanine



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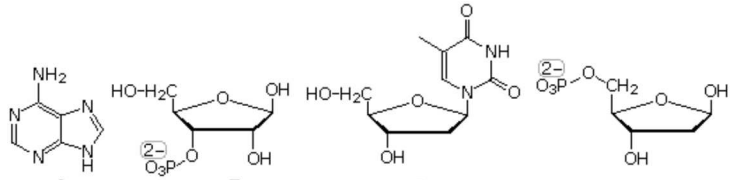
71 Which of the following is a nucleoside?



---

72 In DNA replication the complementary nucleotide sequence for 5'-ACGT-3' is which of the following?
A) 3'-ACGT-5'
B) 3'-TGCA-5'
C) 5'-AGCT-3'
D) 5'-TCGA-3'

---

73 What is the complementary RNA sequence for the DNA segment AATCAGTT?
A) AAUCAGUU
B) CCAUCGAA
C) AACUGAUU
D) UUAGUCAA

---

74 How many nucleotides are needed to code for a specific amino acid?
A) one
B) two
C) three
D) four

Check Answers Reset/Clear View Answers