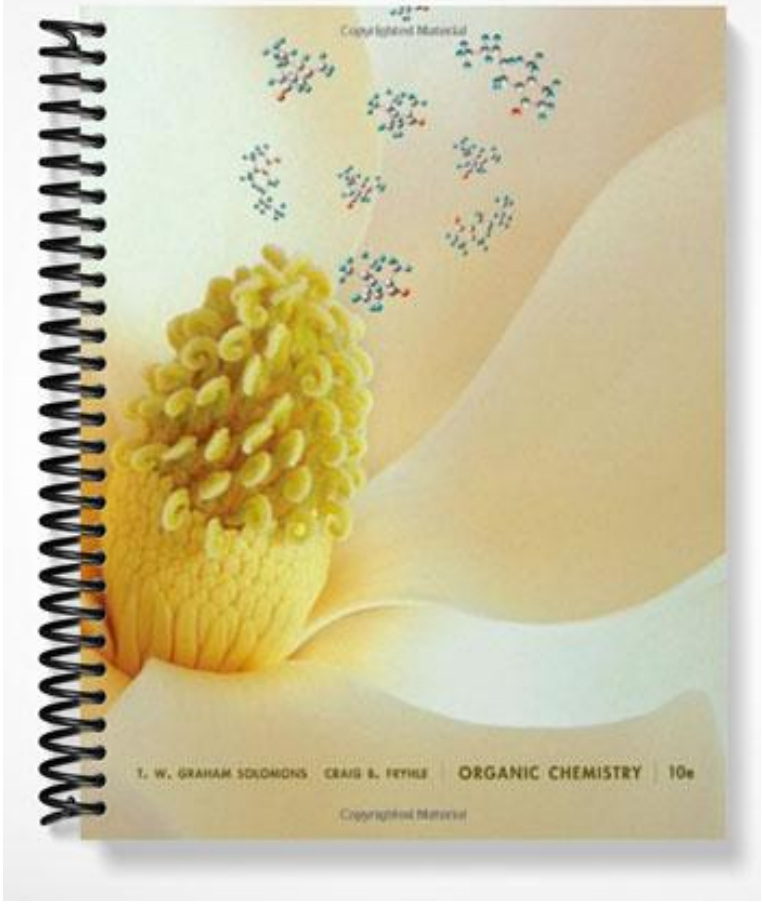
TEST BANK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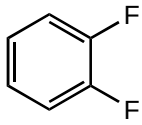
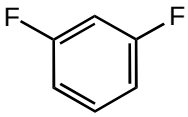
Chapter Two

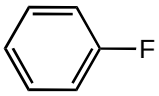
MULTIPLE CHOICE QUESTIONS

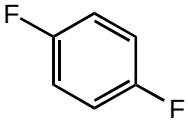
Topic: Molecular geometry, polarity
Section: 2.3
Difficulty Level: Easy

1. Which molecule does not have a dipole moment?

A) 

B) 

C) 

D) 

E) None of these

Ans: D

Topic: Molecular geometry, polarity
Section: 2.3
Difficulty Level: Easy

2. Of the following solvents which one does ***not*** have a zero dipole moment?

A) Pentane
B) Cyclohexane
C) Diethyl ether
D) Cyclopentane
E) None of these

Ans: C

Topic: Molecular geometry, polarity
Section: 2.3
Difficulty Level: Easy

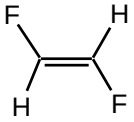
3. Which molecule has a zero dipole moment?

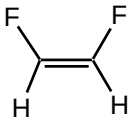
A) CH_3Cl
B) CH_2Cl_2
C) $CHCl_3$
D) CCl_4
E) None of these

Ans: D

Topic: Molecular geometry, dipole moment
Section: 2.3
Difficulty Level: Easy

4. Which molecule would you expect to have no dipole moment (i.e., $\mu = 0$ D)?

A) CHF_3
B) 

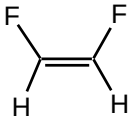
C) $:NF_3$
D) 

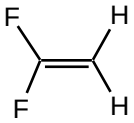
E) CH_2F_2

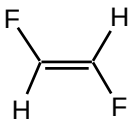
Ans: B

Topic: Molecular geometry, dipole moment
Section: 2.3
Difficulty Level: Easy

5. Which molecule has a dipole moment greater than zero?

A) 

B) 

C) 

D) More than one of these
E) None of these
Ans: D

Topic: Molecular geometry, dipole moment
Section: 2.3
Difficulty Level: Medium

6. Which of the following would have no net dipole moment (μ = 0 D)?

A) CBr_4
B) cis-1,2-Dibromoethene
C) trans:-1,2-Dibromoethene
D) 1,1-Dibromoethene
E) More than one of these
Ans: E

Topic: Molecular geometry, polarity
Section: 2.3
Difficulty Level: Medium

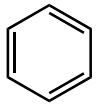
7. For a molecule to possess a dipole moment, which following condition is necessary but not sufficient?

A) Three or more atoms in the molecule
B) Presence of one or more polar bonds
C) A non-linear structure
D) Presence of oxygen or fluorine
E) Absence of a carbon-carbon double or triple bond
Ans: B

Topic: Molecular geometry, polarity
Section: 1.5 and 2.3
Difficulty Level: Easy

8. Which molecule has a zero dipole moment?
A) SO_2
B) CO_2
C) CO
D) $CHCl_3$
E) None of these
Ans: B

Topic: Molecular geometry, polarity
Section: 1.5 and 2.3
Difficulty Level: Easy

9. Which molecule has a zero dipole moment?
A) CO_2
B) CH_4
C) CH_3CH_3
D) 
E) All of these
Ans: E

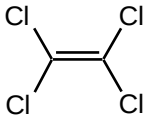
Topic: Molecular geometry, polarity
Section: 1.5 and 2.3
Difficulty Level: Medium

10. Which molecule has a dipole moment of zero?
A) $CHCl_3$
B) CH_2Cl_2
C) $ClHC=CH_2$
D) trans-ClHC=CHCl
E) None of these
Ans: D

Topic: Molecular geometry, polarity
Section: 1.5 and 2.3
Difficulty Level: Medium

11. Which molecule would have a dipole moment greater than zero?
A) $BeCl_2$
B) BCl_3
C) CO_2
D) H_2O
E) CCl_4
Ans: D

Topic: Molecular geometry, polarity
Section: 1.5, 1.6 and 2.3
Difficulty Level: Medium

12. A non-zero dipole moment is exhibited by:
A) SO_2
B) CO_2
C) CCl_4
D) BF_3
E) 

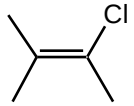
Ans: A

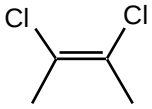
Topic: Molecular geometry, polarity
Section: 1.5, 1.6, and 2.3
Difficulty Level: Hard

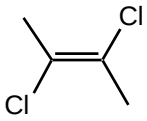
13. Of the following common organic solvents which one is predicted to have a smaller dipole moment?
A) Chloroform, $CHCl_3$
B) Acetone, $(CH_3)_2CO$
C) Dimethylsulfoxide, $(CH_3)_2SO$
D) Acetonitrile, CH_3CN
E) Methanol, CH_3OH
Ans: A

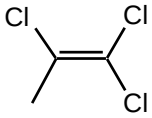
Topic: Molecular geometry, Polarity
Section: 2.3A
Difficulty Level: Easy

14. Which molecule(s) has/have dipole moment(s) equal to zero?

A) 

B) 

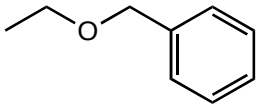
C) 

D) 

E) None of these have dipole moment equal to zero.
Ans: C

Topic: Functional groups
Section: 2.4
Difficulty Level: Easy

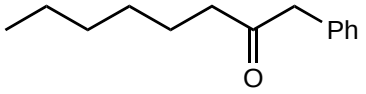
15. What alkyl groups make up the following ether?



A) ethyl and phenyl
B) propyl and benzyl
C) ethyl and benzyl
D) propyl and phenyl
E) None of these
Ans: C

Topic: Functional groups
Section: 2.4
Difficulty Level: Medium

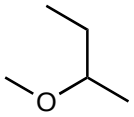
16. What alkyl groups make up the following ketone?



A) Phenyl, pentyl
B) Hexyl, phenyl
C) Benzyl, hexyl
D) Benzyl, heptyl
E) None of these
Ans: C

Topic: Functional groups
Section: 2.4A
Difficulty Level: Easy

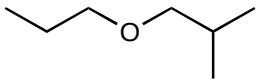
17. What alkyl groups make up the following ether?



A) Isobutyl and methyl
B) Methyl and butyl
C) Ethyl and isopropyl
D) Methyl and *sec*-butyl
E) None of these
Ans: D

Topic: Functional groups
Section: 2.4A
Difficulty Level: Easy

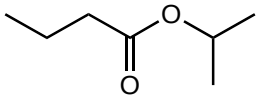
18. What alkyl groups make up the following ether?



A) isobutyl and propyl
B) propyl and butyl
C) ethyl and isopropyl
D) propyl and *sec*-butyl
E) None of these
Ans: A

Topic: Functional groups
Section: 2.4A
Difficulty Level: Easy

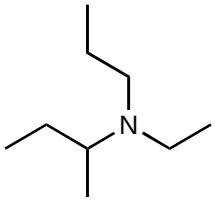
19. What alkyl group is attached to the oxygen in the following ester?



A) ethyl
B) propyl
C) *sec*-propyl
D) isopropyl
E) None of these
Ans: D

Topic: Functional groups
Section: 2.4A
Difficulty Level: Easy

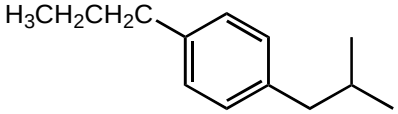
20. What alkyl groups make up the following 3^{o} amine?



A) *sec*-butyl, ethyl, propyl
B) isobutyl, isopropyl, ethyl
C) *sec*-butyl, ethyl, isopropyl
D) butyl, ethyl, propyl
E) None of these
Ans: A

Topic: Functional groups
Section: 2.4A
Difficulty Level: Easy

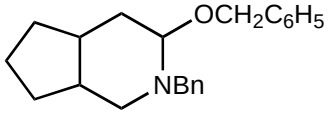
21. What alkyl groups are attached to the benzene ring in the following example?



A) ethyl, butyl
B) ethyl, isobutyl
C) proplyl, *sec*-butyl
D) propyl, butyl
E) None of these
Ans: E

Topic: Functional groups
Section: 2.4B
Difficulty Level: Medium

22. What common group is attached to both the ether and 3° amine in the following molecule?



A) benzyl
B) phenyl
C) heptyl
D) ethyl
E) None of these
Ans: A

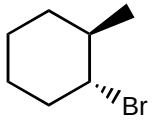
Topic: Functional groups
Section: 2.4B
Difficulty Level: Medium

23. What group makes up the following aldehyde (benzaldehyde)?
C_6H_5CHO

A) benzyl
B) phenyl
C) heptyl
D) ethyl
E) None of these
Ans: B

Topic: Functional groups
Section: 2.5
Difficulty Level: Easy

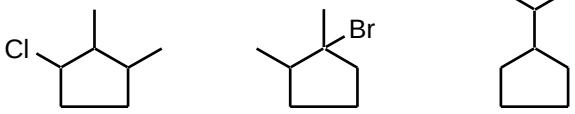
24. What functional group is present in the following compound?



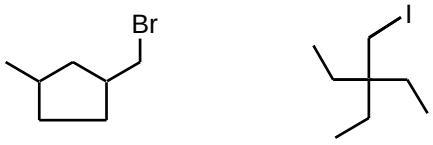
A) 1° alkyl bromide
B) 2° alcohol
C) 2° alkyl bromide
D) 1° amine
E) 3° alkyl bromide
Ans: C

Topic: Functional Groups
Section: 2.5
Difficulty Level: Easy

25. Which is a 3° alkyl halide?



I II III

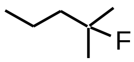


IV V

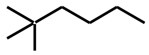
A) I
B) II
C) III
D) IV
E) V
Ans: B

Topic: Functional groups
Section: 2.5
Difficulty Level: Medium

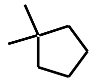
26. Which compound(s) contain(s) tertiary carbon atom(s)?



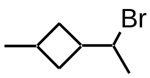
I



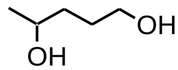
II



III



IV



V

A) I, II, III
B) I
C) II, III
D) I, IV
E) V
Ans: D

Topic: Functional groups
Section: 2.5
Difficulty Level: Medium

27. Which of these compounds is a secondary alkyl chloride?
A) $CH_3CH_2CH_2CH_2CH_2Cl$
B)
$$\begin{array}{c} CH_3 \\ | \\ CH_3CCH_2CH_3 \\ | \\ Cl \end{array}$$
C)
$$\begin{array}{l} CH_3CHCH_2CH_2CH_3 \\ \quad\;\; | \\ \quad\;\; Cl \end{array}$$
D) $(CH_3)_2CHCHClCH_3$
E) Two of these
Ans: E

Topic: Functional groups, Isomerism
Section: 1.3A and 2.5
Difficulty Level: Medium

28. How many 2º alkyl bromides, neglecting stereoisomers, exist with the formula $C_6H_{13}Br$?
A) 4
B) 5
C) 6
D) 7
E) 8
Ans: C

Topic: Isomers
Section: 1.3A and 2.5
Difficulty Level: Medium

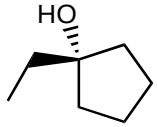
29. The number of unique open-chain structures corresponding to the molecular formula C_3H_5Cl is:
A) 2
B) 3
C) 4
D) 5
E) 6
Ans: C

Topic: Functional groups
Section: 2.6
Difficulty Level: Easy

30. Which compound listed below is a secondary alcohol?
A) $CH_3CHCH_2CH_3$ (OH)
B) CH_3CHCH_2OH (CH_3)
C) CH_3COH (CH_3, CH_3)
D) $CH_3CH_2CH_2CH_2OH$
E) $CH_3CH_2CH_2OCH_3$
Ans: A

Topic: Functional groups
Section: 2.6
Difficulty Level: Easy

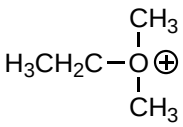
31. What functional group is present in the following compound?



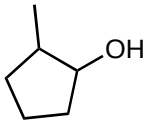
A) 1º alcohol
B) ether
C) 2º alcohol
D) ester
E) 3º alcohol
Ans: E

Topic: Functional groups
Section: 2.6
Difficulty Level: Medium

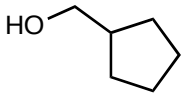
32. Which compound is a tertiary alcohol?



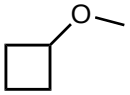
I



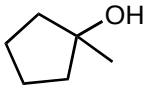
II



III



IV

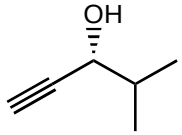


V

A) I
B) II
C) III
D) IV
E) V
Ans: E

Topic: Functional groups
Section: 2.1 and 2.6
Difficulty Level: Easy

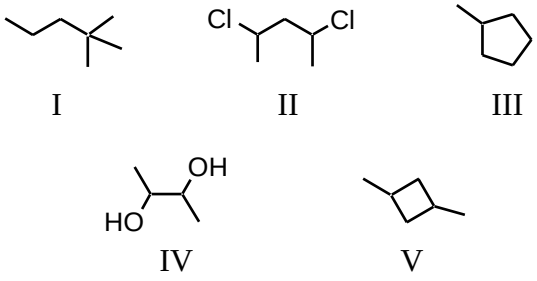
33. What functional group(s) is/are present in the following compound?



A) alkyne and 2^{o} alcohol
B) alkyne and 1^{o} alcohol
C) 2^{o} alcohol and alkene
D) nitrile and 1^{o} alcohol
E) alkene and 2^{o} alcohol
Ans: A

Topic: Functional groups
Section: 2.5 and 2.6
Difficulty Level: Easy

34. A tertiary carbon atom is present in which of these compounds?

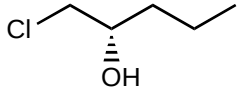


I II III IV V

A) I
B) II, IV
C) III, V
D) IV
E) All of these
Ans: C

Topic: Functional groups
Section: 2.5 and 2.6
Difficulty Level: Easy

35. What functional group(s) is/are present in the following compound?



A) 1° alcohol and 2° alkyl chloride
B) ether and 2° alcohol
C) 1° alkyl chloride and 1° alcohol
D) 1° alkyl chloride and 2° alcohol
E) None of these
Ans: D

Topic: Functional groups, Isomerism
Section: 1.3A, 2.6, and 2.7
Difficulty Level: Easy

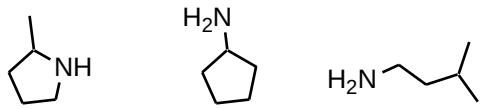
36. How many constitutional isomers are possible with the formula $C_4H_{10}O$?
A) 3
B) 4
C) 5
D) 6
E) 7
Ans: E

Topic: Functional groups
Section: 2.8
Difficulty Level: Easy

37. Which compound is a secondary amine?
A) $CH_3CH_2CH_2NH_2$
B) $CH_3CH(NH_2)CH_3$
C) $CH_3CH_2NHCH_3$
D) $(CH_3)_3N$
E) $CH_3CH_2CH(CH_3)NH_2$
Ans: C

Topic: Functional groups
Section: 2.8
Difficulty Level: Easy

38. Which compound is a primary amine with the formula $C_5H_{13}N$?



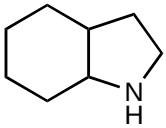
I II III

IV V

A) I
B) II
C) III
D) IV
E) V
Ans: C

Topic: Functional groups
Section: 2.8
Difficulty Level: Easy

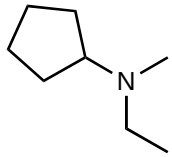
39. What functional group is present in the following compound?



A) 1° alkyl bromide
B) 2° amine
C) nitrile
D) 1° amine
E) 3° amine
Ans: B

Topic: Functional groups
Section: 2.8
Difficulty Level: Easy

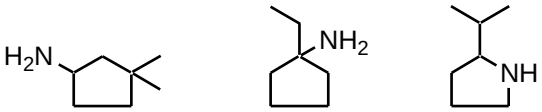
40. What functional group is present in the following compound?



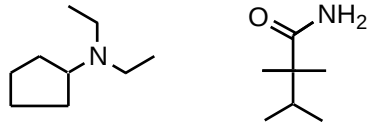
A) 1° alkyl bromide
B) 2° amine
C) nitrile
D) 1° amine
E) 3° amine
Ans: E

Topic: Functional groups
Section: 2.8
Difficulty Level: Easy

41. Which is a 3° amine?



I II III

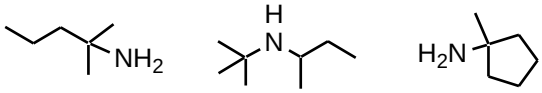


IV V

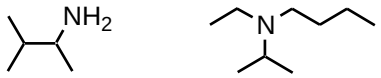
A) I
B) II
C) III
D) IV
E) V
Ans: D

Topic: Functional groups
Section: 2.8
Difficulty Level: Easy

42. An example of a tertiary amine is:



I II III

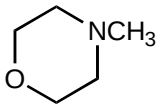


IV V

A) I
B) II
C) III
D) IV
E) V
Ans: E

Topic: Functional groups
Section: 2.7 and 2.8
Difficulty Level: Easy

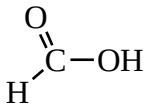
43. What functional group(s) is/are present in the following compound?

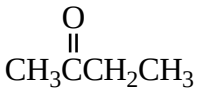


A) ether and 2^{o} amine
B) ester and 3^{o} amine
C) 3^{o} amine
D) 3^{o} amine and ether
E) None of these
Ans: D

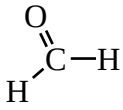
Topic: Functional groups
Section: 2.9
Difficulty Level: Easy

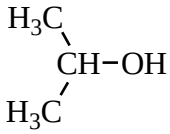
44. Which compound is a ketone?

A) 

B) 

C) 

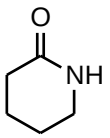
D) 

E) 

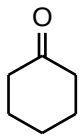
Ans: B

Topic: Functional groups
Section: 2.9
Difficulty Level: Easy

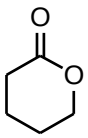
45. Which compound is an aldehyde?



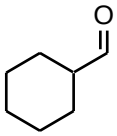
I



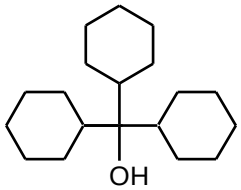
II



III



IV

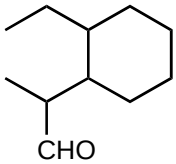


V

A) I
B) II
C) III
D) IV
E) V
Ans: D

Topic: Functional groups
Section: 2.9
Difficulty Level: Medium

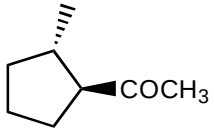
46. What functional group is present in the following compound?



A) alcohol
B) ketone
C) aldehyde
D) ester
E) ether
Ans: C

Topic: Functional groups
Section: 2.9
Difficulty Level: Medium

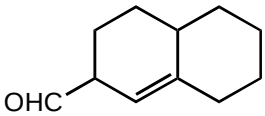
47. What functional group is present in the following compound?



A) alcohol
B) ketone
C) aldehyde
D) ester
E) ether
Ans: B

Topic: Functional groups
Section: 2.1 and 2.9
Difficulty Level: Medium

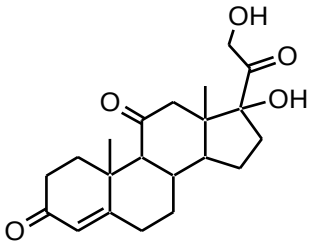
48. What functional group(s) is/are present in the following compound?



A) Ketone and alkene
B) Ketone and alkyne
C) Aldehyde and alkene
D) Aldehyde and alkyne
E) 1^{o} alcohol and alkene
Ans: C

Topic: Functional groups
Section: 2.1, 2.6, and 2.9
Difficulty Level: Easy

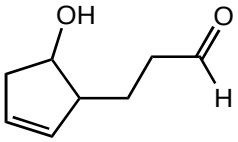
49. The compound below is an adrenocortical hormone called cortisone. Which functional group is *not* present in cortisone?



A) 1° alcohol
B) Ketone
C) 3° alcohol
D) Carboxylic acid
E) Alkene
Ans: D

Topic: Functional groups
Section: 2.1, 2.6, and 2.9
Difficulty Level: Easy

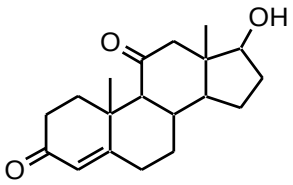
50. Which functional groups are present in the following compound?



A) Alkene, 1º alcohol, ketone
B) Alkene, 2º alcohol, aldehyde
C) Alkene, 2º alcohol, ketone
D) Alkyne, 1º alcohol, aldehyde
E) Alkyne, 2º alcohol, ketone
Ans: B

Topic: Functional groups
Section: 2.1, 2.6, and 2.9
Difficulty Level: Easy

51. The compound shown below is the male sex hormone, testosterone.



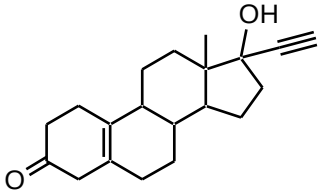
In addition to a cycloalkane skeleton, testosterone also contains the following functional groups:

A) Alkene, ester, tertiary alcohol.
B) Alkene, ether, secondary alcohol.
C) Alkene, ketone, secondary alcohol.
D) Alkyne, ketone, secondary alcohol.
E) Alkene, ketone, tertiary alcohol.

Ans: C

Topic: Functional groups
Section: 2.1, 2.6, and 2.9
Difficulty Level: Medium

52. The compound shown below is a synthetic estrogen. It is marketed as an oral contraceptive under the name Enovid.



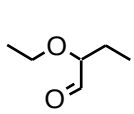
In addition to an alkane (actually cycloalkane) skeleton, the Enovid molecule also contains the following functional groups:

A) Ether, alcohol, alkyne.
B) Aldehyde, alkene, alkyne, alcohol.
C) Alcohol, carboxylic acid, alkene, alkyne.
D) Ketone, alkene, alcohol, alkyne.
E) Amine, alkene, ether, alkyne.

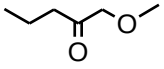
Ans: D

Topic: Functional Groups
Section: 2.7 and 2.9
Difficulty Level: Easy

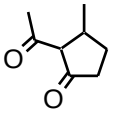
53. Many organic compounds contain more than one functional group. Which of the following is/are both an aldehyde and an ether?



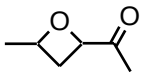
I



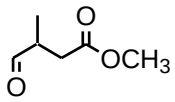
II



III



IV

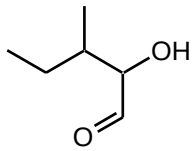


V

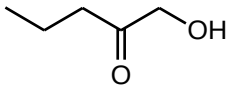
A) I
B) II, IV
C) V
D) I, V
E) III
Ans: A

Topic: Functional groups
Section: 2.10A
Difficulty Level: Easy

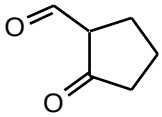
54. Which is a carboxylic acid?



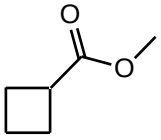
I



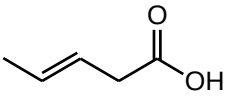
II



III



IV

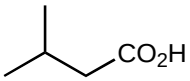


V

A) I
B) II
C) III
D) IV
E) V
Ans: E

Topic: Functional groups
Section: 2.10A
Difficulty Level: Medium

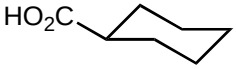
55. What functional group(s) is/are present in the following compound?



A) 1° alcohol and ketone
B) carboxylic acid
C) ester
D) 1° alcohol and aldehyde
E) alcohol
Ans: B

Topic: Functional groups
Section: 2.10A
Difficulty Level: Medium

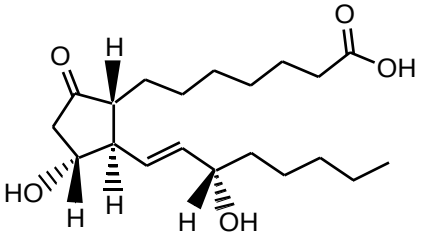
56. What functional group(s) is/are present in the following compound?



A) 1° alcohol and ketone
B) ester
C) carboxylic acid
D) 1° alcohol and aldehyde
E) alcohol
Ans: C

Topic: Functional groups
Section: 2.1, 2.6, 2.9, and 2.10A
Difficulty Level: Medium

57. Which functional group is *not* contained in prostaglandin E_1?

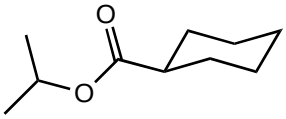


Prostaglandin E_1

A) Ketone
B) 2° alcohol
C) 3° alcohol
D) Carboxylic acid
E) Alkene
Ans: C

Topic: Functional groups
Section: 2.10B
Difficulty Level: Easy

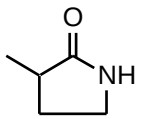
58. What functional group(s) is/are present in the following compound?



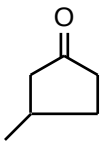
A) ether and ketone
B) carbonyl and ether
C) carboxylic acid and ether
D) ester
E) 1° alcohol
Ans: D

Topic: Functional groups
Section: 2.10B
Difficulty Level: Easy

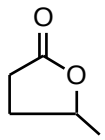
59. Which compound is an ester?



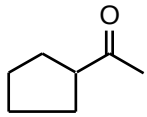
I



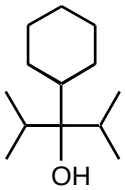
II



III



IV

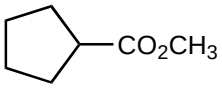


V

A) I
B) II
C) III
D) IV
E) V
Ans: C

Topic: Functional groups
Section: 2.10B
Difficulty Level: Medium

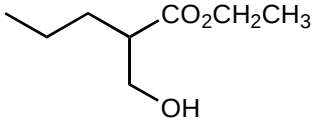
60. What functional group is present in the following compound?



A) alcohol
B) ketone
C) aldehyde
D) ester
E) ether
Ans: D

Topic: Functional groups
Section: 2.6 and 2.10B
Difficulty Level: Medium

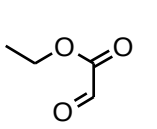
61. What functional group(s) is/are present in the following compound?



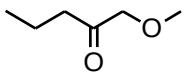
A) Ketone and 1^{o} alcohol
B) Ether and alcohol
C) Ester and ether
D) Ester and 1^{o} alcohol
E) 1^{o} alcohol and aldehyde
Ans: D

Topic: Functional groups
Section: 2.9 and 2.10B
Difficulty Level: Medium

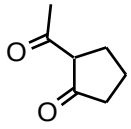
62. Which compound can be classified as an ester as well as a ketone?



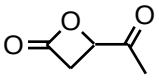
I



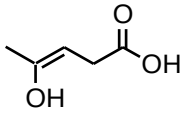
II



III



IV

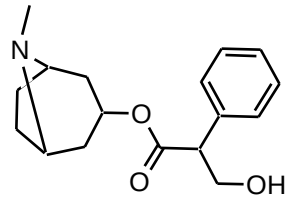


V

A) I
B) II
C) III
D) IV
E) V
Ans: D

Topic: Functional groups
Section: 2.1, 2.6, 2.8, and 2.10B
Difficulty Level: Hard

63. Drawn below is *Atropine*, found in *Atropa belladonna*, sometimes used in dilating pupils during an eye-exam. Which of the following functional groups is NOT in atropine?

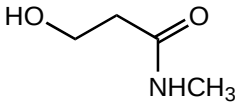


Atropine

A) Amine
B) Ester
C) Alcohol
D) Benzene Ring
E) Ketone
Ans: E

Topic: Functional groups
Section: 2.6 and 2.10C
Difficulty Level: Medium

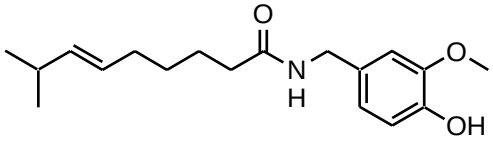
64. What functional group(s) is/are present in the following compound?



A) 1^o alcohol and 2^o amine
B) amide and 2^o alcohol
C) nitrile and 1^o alcohol
D) 2^o amide and ether
E) None of these
Ans: E

Topic: Functional groups
Section: 2.1, 2.6, 2.7, and 2.10C
Difficulty Level: Medium

65. The compound shown below is a substance called *Capsaicin*, found in varying concentrations in several varieties of hot peppers, and responsible for their respective degrees of "heat". Which functional groups *are* present in the molecule of capsaicin?

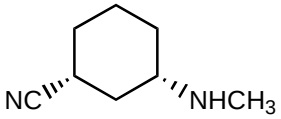


Capsaicin

A) Alkene, ketone, amine, alcohol, ester
B) Alkene, ketone, alcohol, ether
C) Alkene, amine, phenol, ether
D) Ether, phenol, alkene, amide
E) Ester, phenol, alkene, amide
Ans: D

Topic: Functional groups
Section: 2.8 and 2.11
Difficulty Level: Medium

66. What functional group(s) is/are present in the following compound?



A) 1^o amine and 2^o amine
B) amide and 2^o amine
C) 2^o amine and nitrile
D) nitrile and 1^o amine
E) amide and nitrile
Ans: C

Topic: Intermolecular forces
Section: 2.13
Difficulty Level: Easy

67. The strongest of attractive forces is which type?
A) Dispersion forces
B) Ion-dipole
C) Dipole-dipole
D) Cation-anion
E) Hydrogen bonds
Ans: D

Topic: Intermolecular forces
Section: 2.13
Difficulty Level: Easy

68. Which of these is the weakest of the intermolecular attractive forces?
A) Ion-ion
B) Dispersion forces
C) Dipole-dipole
D) Covalent bonding
E) Hydrogen bonding
Ans: B

Topic: Intermolecular forces
Section: 2.13
Difficulty Level: Medium

69. Which compound would you expect to have the highest melting point?
A) n-Butyl alcohol
B) Isobutyl alcohol
C) sec-Butyl alcohol
D) tert-Butyl alcohol
E) Diethyl ether
Ans: D

Topic: Intermolecular forces
Section: 2.13
Difficulty Level: Medium

70. Which of the following is not found in the following substance?

$CH_3CH_2CH_2CH_2CH_2OH$

A) Ion-ion
B) Dispersion forces
C) Dipole-dipole
D) Covalent bonding
E) Hydrogen bonding

Ans: A

Topic: Intermolecular forces
Section: 2.13
Difficulty Level: Medium

71. Which alkane is predicted to have the highest melting point of those shown?

A) $CH_3CH_2CH_2CH_3$
B) CH_3CHCH_3 (with CH_3 branch)
C) $CH_3CH_2CH_2CH_2CH_3$
D) $CH_3CHCH_2CH_3$ (with CH_3 branch)
E) CH_3CCH_3 (with two CH_3 branches)

Ans: E

Topic: Intermolecular forces
Section: 2.13B
Difficulty Level: Easy

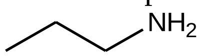
72. What intermolecular forces hold base pairs together in DNA?

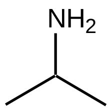
A) Ion-ion
B) Dipole-dipole
C) Hydrogen bonds
D) Dispersion forces
E) Covalent bonds

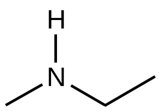
Ans: C

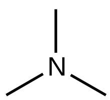
Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Easy

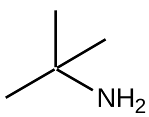
73. Which compound would you expect to have the lowest boiling point?

A) 

B) 

C) 

D) 

E) 

Ans: D

Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Easy

74. Which of these compounds would have the highest boiling point?

A) $CH_3OCH_2CH_2CH_2OCH_3$
B) $CH_3CH_2OCH_2CH_2OCH_3$
C) $CH_3CH_2OCH_2OCH_2CH_3$
D) $CH_3OCH_2CH(CH_3)OCH_3$ (drawn with the CH_3 hanging below the CH)
E) $HOCH_2CH_2CH_2CH_2CH_2OH$

Ans: E

Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Easy

75. Which compound would have the highest boiling point?
A) $CH_3CH_2CH_2CH_2CH_2CH_3$
B) $CH_3CH_2OCH_2CH_2CH_3$
C) $CH_3CH_2CH_2CH_2CH_2OH$
D) $CH_3CH_2OCH(CH_3)_2$
E) $CH_3OCH_2CH_2CH_2CH_3$
Ans: C

Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Easy

76. Of the following compounds, the one with the highest boiling point is:
A) CH_3CH_3
B) CH_3CH_2Cl
C) $CH_3C(=O)H$
D) CH_3CH_2OH
E) $CH_3CH_2OCH_2CH_3$
Ans: D

Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Medium

77. Which compound would you expect to have the highest boiling point?
A) ethane
B) ethene
C) ethyne
D) bromoethane
E) methane
Ans: D

Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Medium

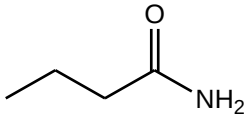
78. Which compound would you expect to have the highest boiling point?
A) ethyl alcohol
B) ethyl amine
C) chloroethane
D) water
E) ethane
Ans: D

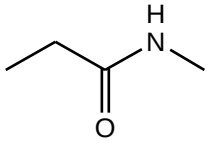
Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Medium

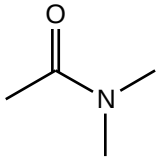
79. Which of these would you expect to have the lowest boiling point?
A) $CH_3CH_2CH_2OH$
B) CH_3CHCH_3 (OH)
C) $CH_3OCH_2CH_3$
D) $CH_3CH_2CH_2CH_2OH$
E) $CH_3CH_2OCH_2CH_3$
Ans: C

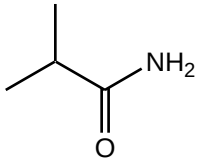
Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Medium

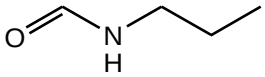
80. Which compound would you expect to have the lowest boiling point?

A) 

B) 

C) 

D) 

E) 

Ans: C

Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Medium

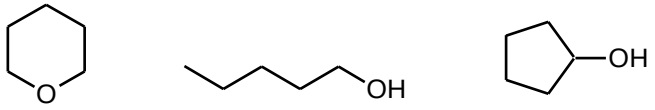
81. Which compound would you expect to have the highest boiling point?

A) $CH_3OCH_2CH_2OCH_3$
B) $CH_3OCH_2OCH_2CH_3$
C) $HOCH_2CH_2CH_2CH_2OH$
D) $CH_3OCH_2CH_2CH_2OH$
E) $(CH_3O)_2CHCH_3$

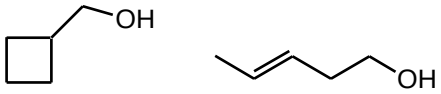
Ans: C

Topic: Intermolecular forces
Section: 2.13C
Difficulty Level: Medium

82. Which compound would have the lowest boiling point?



I II III



IV V

A) I
B) II
C) III
D) IV
E) V
Ans: A

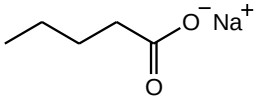
Topic: Intermolecular forces
Section: 2.13D
Difficulty Level: Easy

83. The solid alkane $CH_3(CH_2)_{18}CH_3$ is expected to exhibit the greatest solubility in which of the following solvents?

A) CCl_4
B) CH_3OH
C) H_2O
D) CH_3NH_2
E) $HOCH_2CH_2OH$
Ans: A

Topic: Intermolecular forces
Section: 2.13D
Difficulty Level: Easy

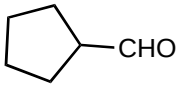
84. The following substance is expected to have low solubility in which of the following solvent(s)?



A) CCl_4
B) C_2H_5OH
C) $CHCl_3$
D) $CH_2OHCH_2CH_2CH_2CH_2CH_2OH$
E) The given substance is likely to be quite soluble in all of the solvents described.
Ans: A

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Easy

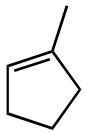
85. For the functional group(s) on the following molecule what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



A) A peak around 1700 cm^{-1}
B) A peak around 3300 cm^{-1}
C) Only normal alkane absorptions
D) A peak around 2250 cm^{-1}
E) None of these
Ans: A

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Easy

86. For the functional group(s) on the following molecule what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



A) A peak around 1700 cm^{-1}
B) A peak around 3300 cm^{-1}
C) A peak around 1650 cm^{-1}
D) A peak around 2250 cm^{-1}
E) None of these
Ans: C

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Easy

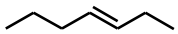
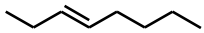
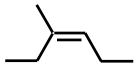
87. The IR spectrum of which type of compound will not show evidence of hydrogen bonding?
A) Aldehyde
B) Alcohol
C) Carboxylic acid
D) Phenol
E) Primary amine
Ans: A

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Easy

88. The IR spectrum of which type of compound generally exhibits evidence of hydrogen bonding?
A) Aldehyde
B) Carboxylic acid
C) Alkene
D) Ester
E) Ketone
Ans: B

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Easy

89. IR evidence for the presence of the C=C would be most difficult to detect in the case of which of these alkenes?

A) 
B) 
C) 
D) 
E) 

Ans: D

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

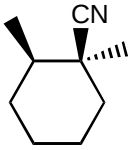
90. An oxygen-containing compound shows strong IR absorption at 1630-1780 cm^{-1} and 3200-3550 cm^{-1}. What type of compound is it likely to be?

A) An alcohol
B) A carboxylic acid
C) An ether
D) A ketone
E) An aldehyde

Ans: B

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

91. For the functional group(s) on the following molecule what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?

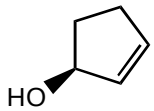


A) A peak around 1700 cm^{-1}
B) A peak around 3300 cm^{-1}
C) A peak around 1650 cm^{-1}
D) A peak around 2250 cm^{-1}
E) None of these

Ans: D

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

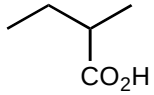
92. For the functional group(s) on the following molecule, what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



A) Peaks around 1700 and 1650 cm^{-1}
B) Peaks around 3300 and 1710 cm^{-1}
C) Peaks around 1650 and 3300 cm^{-1}
D) Only a peak around 3300 cm^{-1}
E) None of these
Ans: C

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

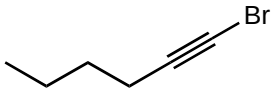
93. For the functional group(s) on the following molecule, what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



A) Peaks around 1700 and 1650 cm^{-1}
B) A strong broad peak over 3600 to 2500 and around 1710 cm^{-1}
C) Peaks around 1650 and 3300 cm^{-1}
D) Peaks around 3300 and 1710 cm^{-1}
E) None of these
Ans: B

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

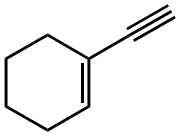
94. For the functional group(s) on the following molecule, what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



A) Peaks around 1710 and 1650 cm^{-1}
B) A strong broad peak over 3600 to 2500 cm^{-1}
C) Peaks around 1650 and 3300 cm^{-1}
D) A peak around 1710 cm^{-1}
E) None of these
Ans: E

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

95. For the functional group(s) on the following molecule, what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



A) Peaks around 3300, 2150, and 1650 cm^{-1}
B) Peaks around 1710 and 1650 cm^{-1}
C) Peaks around 1650 and 3300 cm^{-1}
D) A peak around 2250 and 3300 cm^{-1}
E) None of these
Ans: A

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

96. The absorption band for the O-H stretch in the IR spectrum of an alcohol is sharp and narrow in the case of:
A) a Nujol mull of the alcohol.
B) a concentrated solution of the alcohol.
C) a gas phase spectrum of the alcohol.
D) the spectrum of the neat liquid.
E) none of these
Ans: C

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

97. A split peak for the IR absorption due to bond stretching is observed for the carbonyl group in which of these compounds?

A) $CH_3CH_2CH_2\overset{\overset{O}{\|}}{C}OH$

B) $CH_3CH_2\overset{\overset{O}{\|}}{C}Cl$

C) $CH_3CH_2\overset{\overset{O}{\|}}{C}NH_2$

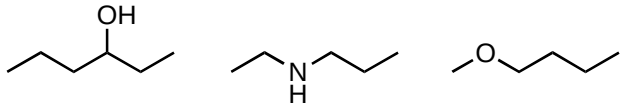
D) $CH_3CH_2\overset{\overset{O}{\|}}{C}OCH_2CH_3$

E) $CH_3CH_2\overset{\overset{O}{\|}}{C}O\overset{\overset{O}{\|}}{C}CH_2CH_3$

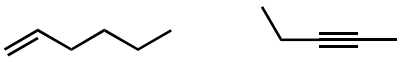
Ans: E

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

98. The IR spectrum of which of the following substances is likely to show a small, but sharp peak at 2200 cm^{-1}?



I II III



IV V

A) I
B) II
C) III
D) IV
E) V

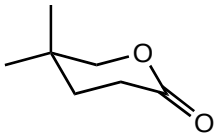
Ans: E

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

99. An anticipated IR absorption band may not be observed because:
A) it occurs outside the range of the instrument used.
B) no change occurs in the dipole moment during the vibration.
C) the absorption band is eclipsed by another.
D) the intensity is so weak that it cannot be differentiated from instrument noise.
E) All of these
Ans: E

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

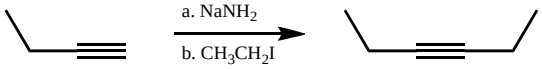
100. For the functional group(s) on the following molecule what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



A) peaks around 1740 and 1650 cm^{-1}
B) A strong broad peak over 3600 to 2500 cm^{-1}
C) peaks around 1650 and 3300 cm^{-1}
D) a peak around 1740 cm^{-1}
E) None of these
Ans: D

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

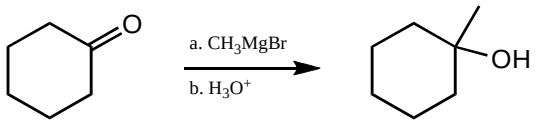
101. For the following reaction sequence (it is not necessary to understand the chemistry) what significant change(s) would be expected by IR (ignoring C-H absorptions)?



A) A peak around 1710 cm^{-1} would disappear.
B) A peak around 1710 cm^{-1} would appear.
C) A peak around 2150 cm^{-1} would disappear.
D) No change would be observed.
E) None of these
Ans: C

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

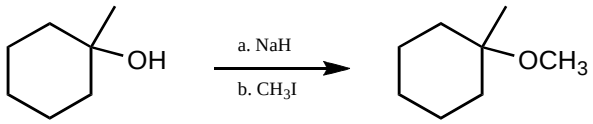
102. For the following reaction sequence (it is not necessary to understand the chemistry) what significant change(s) would be expected by IR (ignoring C-H absorptions)?



A) A peak around 1710 cm^{-1} would disappear and a new peak around 3300-3500 cm^{-1} would appear.
B) A peak around 1710 cm^{-1} would appear and a new peak around 1650 cm^{-1} would disappear.
C) A peak around 2150 cm^{-1} would disappear and a new peak around 3300-3500 cm^{-1} would appear.
D) No change would be observed.
E) None of these
Ans: A

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

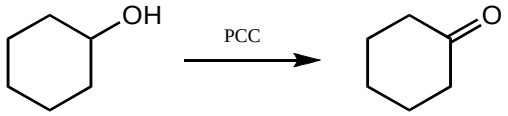
103. For the following reaction sequence (it is not necessary to understand the chemistry) what significant change(s) would be expected by IR (ignoring C-H absorptions)?



A) A peak around 3300 cm^{-1} would disappear .
B) A peak around 1710 cm^{-1} would appear and a new peak around 3300 cm^{-1} would disappear.
C) A peak around 2150 cm^{-1} would disappear and a new peak around 3300 cm^{-1} would appear.
D) No change would be observed.
E) None of these
Ans: A

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

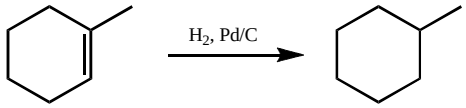
104. For the following reaction sequence (it is not necessary to understand the chemistry) what significant change(s) would be expected by IR (ignoring C-H absorptions)?



A) A peak around 3300 cm^{-1} would disappear and nothing new would appear.
B) A peak around 1710 cm^{-1} would appear and a new peak around 3300 cm^{-1} would disappear.
C) A peak around 2150 cm^{-1} would disappear and a new peak around 3300 cm^{-1} would appear.
D) No change would be observed.
E) None of these
Ans: B

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

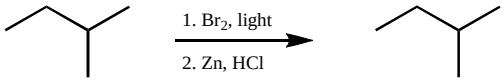
105. For the following reaction sequence (it is not necessary to understand the chemistry) what significant change(s) would be expected by IR (ignoring C-H absorptions)?



A) A peak around 3300 cm^{-1} would disappear and nothing new would appear
B) A peak around 1710 cm^{-1} would appear and a new peak around 3300 cm^{-1} would disappear.
C) A peak around 1650 cm^{-1} would disappear and nothing new would appear.
D) No change would be observed.
E) None of these
Ans: C

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

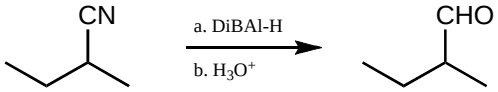
106. For the following reaction sequence (it is not necessary to understand the chemistry) what significant overall change(s) would be expected by IR (ignoring C-H absorptions)?



A) A peak around 3300 cm^{-1} would disappear and nothing new would appear.
B) A peak around 1710 cm^{-1} would appear and a new peak around 3300 cm^{-1} would disappear.
C) A peak around 1650 cm^{-1} would disappear and nothing new would appear.
D) No overall change would be observed.
E) None of these
Ans: D

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

107. For the following reaction sequence (it is not necessary to understand the chemistry) what significant change(s) would be expected by IR (ignoring C-H absorptions)?



A) A peak around 2250 cm^{-1} would disappear and nothing new would appear.
B) A peak around 1720 cm^{-1} would appear and a new peak around 3300 cm^{-1} would disappear.
C) A peak around 2250 cm^{-1} would disappear and new peak around 1720 cm^{-1} would appear.
D) A peak around 2250 cm^{-1} would disappear and new peak around 3300 cm^{-1} would appear.
E) No change would be observed.
Ans: C

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

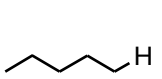
108. The IR stretching frequency occurs at the lowest frequency for which of these bonds?
A) C–H
B) C–O
C) C–Br
D) C–N
E) C–F
Ans: C

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

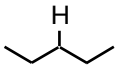
109. The IR stretching frequency can be predicted to occur at the highest frequency for which of these bonds?
A) C–H
B) C–F
C) C–Cl
D) C–Br
E) C–I
Ans: A

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

110. The IR absorption due to the stretching of which of these carbon-hydrogen bonds occurs at the highest frequency?

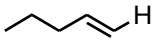


I

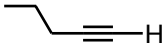


II

III



IV



V

A) I
B) II
C) III
D) IV
E) V
Ans: E

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

111. An oxygen-containing compound which shows sharp IR absorption at 2200 cm^{-1} and 3300 cm^{-1} is likely to be what type of compound?
A) An ester
B) An alkene
C) An alkyne
D) An ether
E) An aldehyde
Ans: C

SHORT ANSWER QUESTIONS

Topic: Functional Groups
Section: 2.1
Difficulty Level: Easy

112. Hydrocarbons containing carbon-carbon double bonds are referred to as _____.

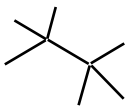
Ans: alkenes

Topic: Functional Groups
Section: 2.1
Difficulty Level: Easy

113. Unsaturated hydrocarbons may be distinguished from saturated hydrocarbons by the presence of one or more _____.
Ans: Pi bonds

Topic: Isomers, Functional Groups
Section: 2.1
Difficulty Level: Easy

114. Draw a structural formula for C_8H_{18} , in which there are two quaternary carbons.
Ans:

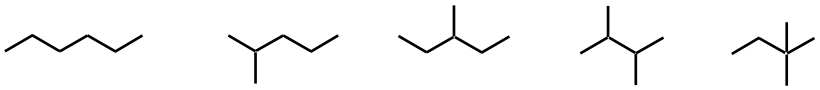


Topic: General
Section: 2.1
Difficulty Level: Easy

115. The six *p*-electrons in benzene are _____ about the ring, which explains why all of the C-C bonds are the same length.
Ans: delocalized

Topic: Isomers, Functional Groups
Section: 1.3A and 2.1
Difficulty Level: Easy

116. Draw all isomers of C_6H_{14}.
Ans:

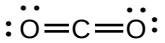


Topic: General
Section: 2.2
Difficulty Level: Easy

117. A polar covalent bond is one in which electrons are _____.
Ans: not shared equally

Topic: Molecular Geometry, Dipole Moment
Section: 2.2 and 2.3
Difficulty Level: Medium

118. Carbon dioxide is non-polar, despite the fact that oxygen is much more electronegative than carbon. Briefly explain why, using relevant diagrams as appropriate to illustrate your Answer.
Ans: The overall dipole moment of a polyatomic molecule depends on two factors: the polarity of various bonds and molecular geometry, since dipole forces have both magnitude and direction. In some molecules containing bonds of identical polarity, the molecular geometry may result in a net cancellation of the overall dipole forces. This is what happens in carbon dioxide: although there are two polar C-O bonds, because of the linear geometry of the molecule, the net dipole is zero.

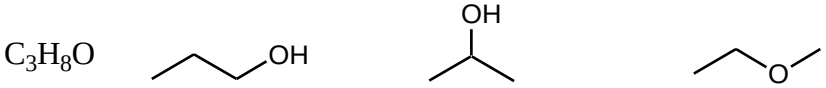


Topic: Functional Groups
Section: 2.4
Difficulty Level: Easy

119. Organic compounds are classified into chemical families on the basis of similarities in chemical properties; these similarities are primarily due to the presence of characteristic arrangements of atoms known as _____.
Ans: functional groups

Topic: Isomers, Functional Groups
Section: 1.3A, 2.6, and 2.7
Difficulty Level: Easy

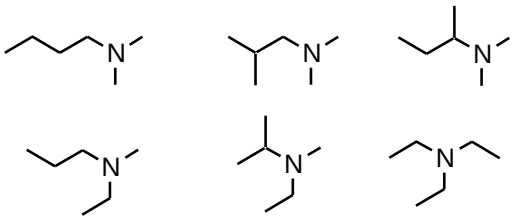
120. Draw all isomers of C_3H_8O and classify each according to functional group.
Ans:



primary alcohol secondary alcohol ether

Topic: Isomers, Functional Groups
Section: 1.3A and 2.8
Difficulty Level: Medium

121. Draw all tertiary amine isomers of $C_6H_{15}N$.
Ans:

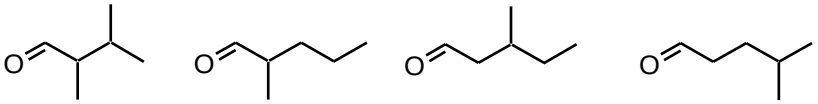


Topic: Functional Groups
Section: 2.9
Difficulty Level: Easy

122. A group in which a carbon atom has a double bond to an oxygen atom is called a _____.
Ans: carbonyl

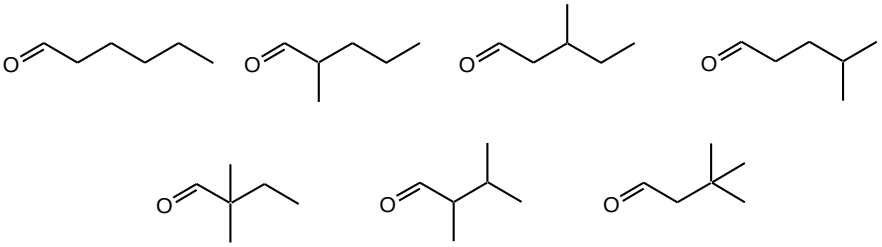
Topic: Isomers, Functional Groups
Section: 2.9
Difficulty Level: Easy

123. Draw all isomers of $C_6H_{12}O$ that are aldehydes and contain at least one secondary carbon.
Ans:



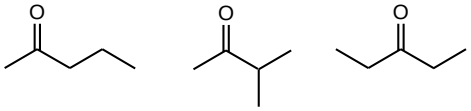
Topic: Isomers, Functional Groups
Section: 1.3A and 2.9
Difficulty Level: Easy

124. Draw all isomers of $C_6H_{12}O$ that are aldehydes.
Ans:



Topic: Isomers, Functional Groups
Section: 1.3A and 2.9
Difficulty Level: Easy

125. Draw all isomers of $C_5H_{10}O$ that are ketones.
Ans:



Topic: Intermolecular Forces
Section: 2.13C
Difficulty Level: Easy

126. Ethanol, C_2H_5OH, and propane, C_3H_8, have approximately the same molar mass, yet ethanol has a much higher boiling point. Briefly explain why.
Ans: Strong hydrogen bonding between molecules of ethanol leads to elevation in boiling point. No hydrogen bonding is possible between molecules of propane, resulting in a lower boiling point compared with ethanol.

Topic: Intermolecular Forces
Section: 2.13C
Difficulty Level: Easy

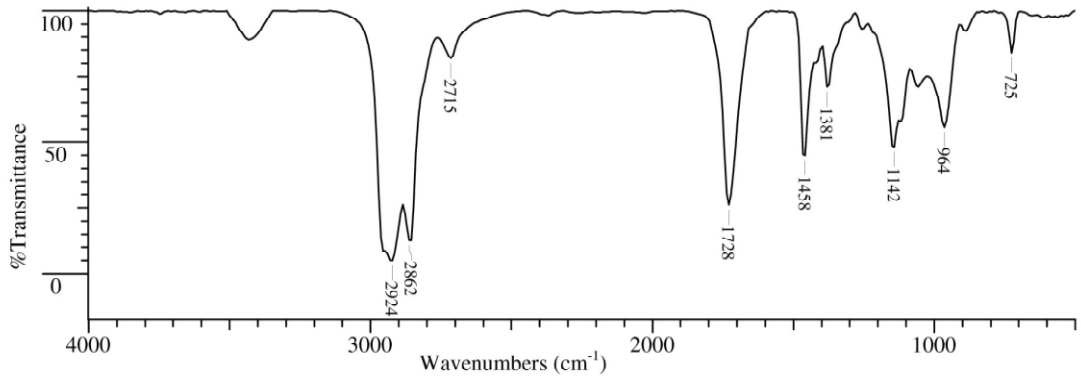
127. Ethanol, C_2H_5OH, and dimethyl ether, CH_3OCH_3, have the same molar mass, yet ethanol has a much higher boiling point. Briefly explain why.
Ans: Strong hydrogen bonding between molecules of ethanol leads to elevation in boiling point. No hydrogen bonding is possible between molecules of dimethyl ether, resulting in a lower boiling point compared with ethanol.

Topic: Bonding, Solubility
Section: 2.13 specifically 2.13D
Difficulty Level: Medium

128. Sodium chloride, which is quite soluble in water, is not very soluble in hexane. Why?
Ans: Sodium chloride, which is an ionic substance, is soluble in a polar solvent such as water, but not in a non-polar solvent such as hexane.

Topic: Functional Groups, IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

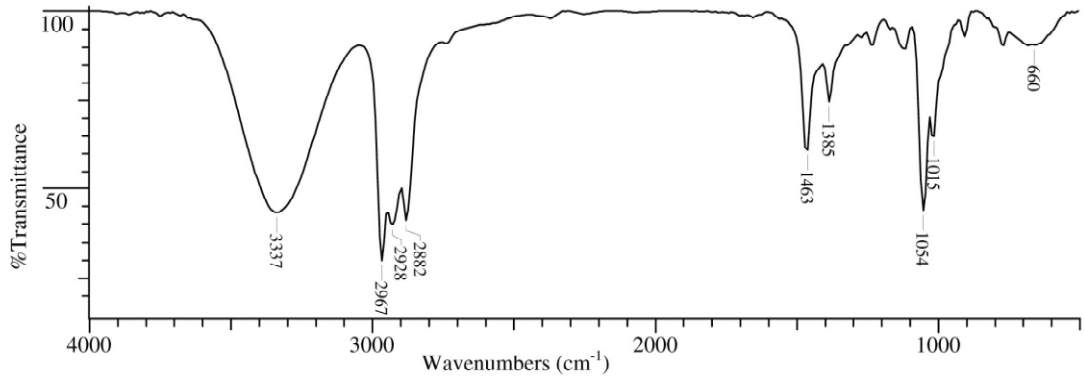
129. Examine the following IR spectrum, for substance **P** ($C_8H_{22}O$). Which oxygen containing functional group is present in **P**?



Ans: An aldehyde

Topic: Functional Groups, IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

130. Examine the following IR spectrum, for substance **P** ($C_5H_{12}O$). Which oxygen containing functional group is present in **P**?



Ans: Alcohol

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Hard

131. The IR absorption frequencies of the C-H bond in alkanes, alkenes and alkynes are measurably different. Briefly explain why.

Ans: IR absorption frequency depends on bond strength; the bond strength of C-H bonds in alkanes, alkenes and alkynes is different because different atomic orbitals (hybridized) of carbon are involved in the bond: the C-H bond in alkanes is described as (sp^3-*s*), that in alkenes is (sp^2-*s*) and in alkynes, it is (*sp*-*s*). The relative % *s* v. % *p* character of the hybrid orbitals of carbon would indicate different bond lengths / bond strengths for alkanes, alkenes and alkynes, with the bond length / bond strength being the longest/weakest respectively. This results in different IR absorption frequencies.

Topic: IR Spectroscopy
Section: 2.15 and 2.16
Difficulty Level: Medium

132. IR absorption signals of alcohols are typically broad. However, IR spectra of gaseous samples show sharp peaks. Briefly explain why.
Ans: Broad signals of alcohols are due to hydrogen bonding associated with the O-H group. In gaseous samples, no hydrogen bonding is possible, and the signal becomes sharp.

Topic: Functional Groups, IR Spectroscopy
Section: 2.1, 2.15, and 2.16
Difficulty Level: Easy

133. An IR spectrum has significant peaks at 3080 and 1650 cm^{-1}. What functional group is present in the molecule?
Ans: An alkene

Topic: Functional Groups, IR Spectroscopy
Section: 2.1, 2.15, and 2.16
Difficulty Level: Hard

134. An IR spectrum has significant peaks at 2200 and 3300 cm^{-1}. What functional group is present in the molecule?
Ans: A terminal alkyne