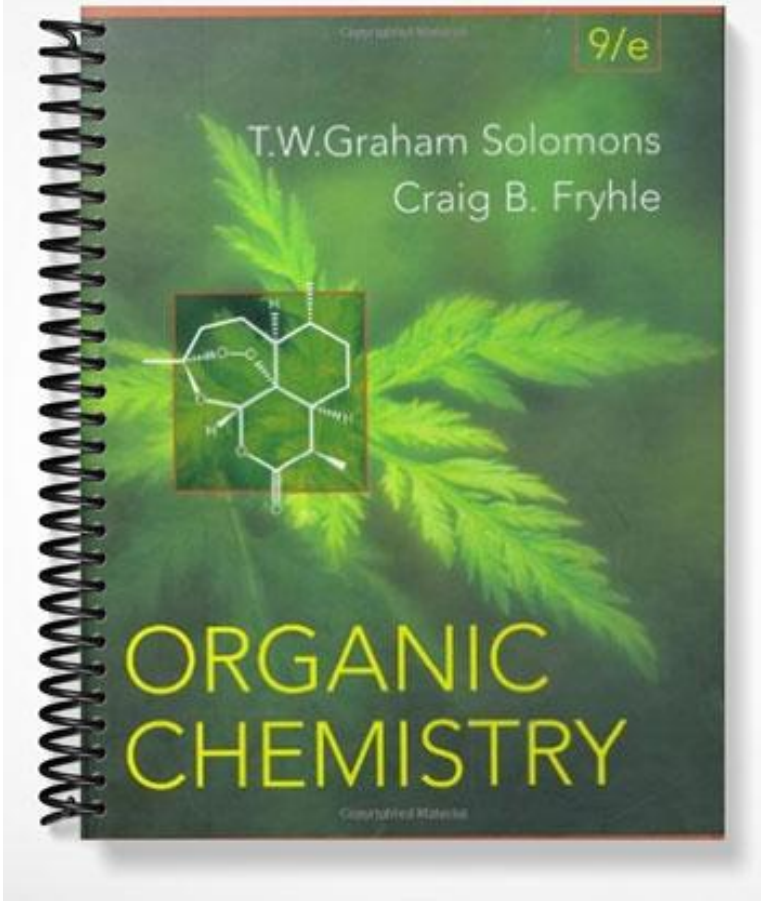
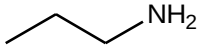
TEST BANK

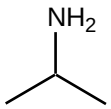


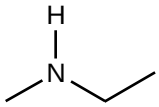
MULTIPLE CHOICE QUESTIONS

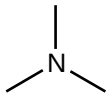
Topic: Intermolecular forces

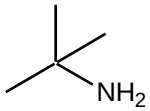
1. Which compound would you expect to have the lowest boiling point?

A) 

B) 

C) 

D) 

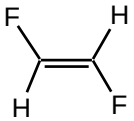
E) 

Ans: D
:

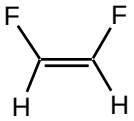
Topic: Molecular geometry, dipole moment

2. 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: Intermolecular forces

3. 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) $CH_3OCH_2CHOCH_3$ with CH_3 branch
E) $HOCH_2CH_2CH_2CH_2CH_2OH$

Ans: E

Topic: Intermolecular forces

4. Which of these would you expect to have the lowest boiling point?

A) $CH_3CH_2CH_2OH$
B) CH_3CHCH_3 with OH branch
C) $CH_3OCH_2CH_3$
D) $CH_3CH_2CH_2CH_2OH$
E) $CH_3CH_2OCH_2CH_3$

Ans: C

Topic: Intermolecular forces

5. 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

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

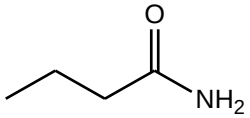
$CH_3CH_2CH_2CH_2CH_2OH$

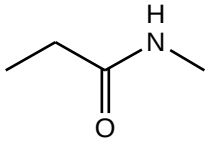
A) Ion-ion
B) van der Waals
C) Dipole-dipole
D) Resonance
E) Hydrogen bonding

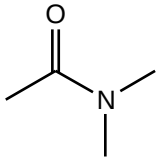
Ans: D

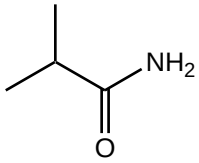
Topic: Intermolecular forces

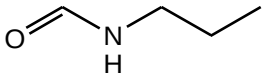
7. Which compound would you expect to have the lowest boiling point?

A) 

B) 

C) 

D) 

E) 

Ans: C

Topic: Intermolecular forces

8. 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: Molecular geometry, dipole moment

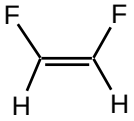
9. Which of the following would have no net dipole moment ($\mu = 0$ D)?

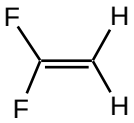
A) CBr_4
B) cis-1,2-Dibromoethene
C) trAns:-1,2-Dibromoethene
D) 1,1-Dibromoethene
E) More than one of these

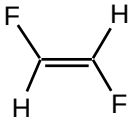
Ans: E

Topic: Molecular geometry, dipole moment

10. Which molecule has dipole moment greater than zero?

A) 

B) 

C) 

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

Topic: Intermolecular forces

11. The <u>strongest</u> of attractive forces is which type?
A) van der Waals
B) Ion-dipole
C) Dipole-dipole
D) Cation-anion
E) Hydrogen bonds
Ans: D

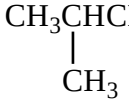
Topic: Intermolecular forces

12. 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

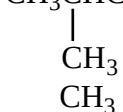
Topic: Intermolecular forces

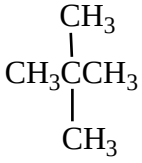
13. This alkane is predicted to have the highest melting point of those shown:

A) $CH_3CH_2CH_2CH_3$

B) 

C) $CH_3CH_2CH_2CH_2CH_3$

D) 

E) 

Ans: E

Topic: Intermolecular forces

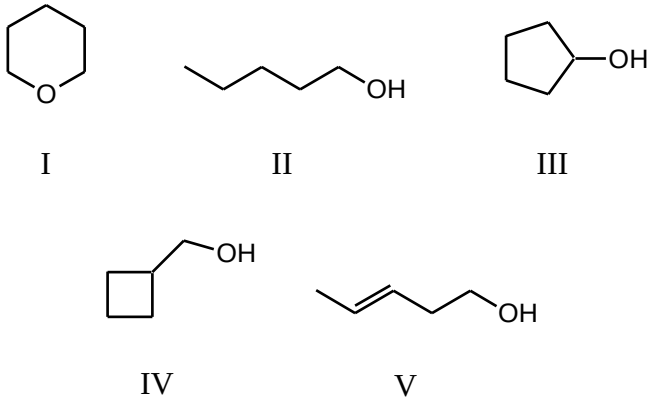
14. The solid alkane $CH_3(CH_2)_{18}CH_3$ is expected to exhibit the greatest solubility in which of the following solvents?

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

Ans: A

Topic: Intermolecular forces

15. Which compound would have the lowest boiling point?



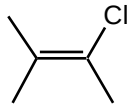
I II III

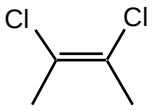
IV V

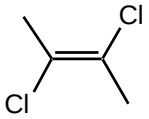
A) I
B) II
C) III
D) IV
E) V
Ans: A

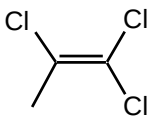
Topic: Molecular geometry, Polarity

16. Which molecule(s) has dipole moment equal to zero?

A) 

B) 

C) 

D) 

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

Topic: Molecular geometry, polarity

17. 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

18. 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

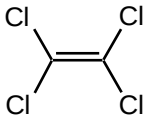
Topic: Molecular geometry, polarity

19. 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

20. For a molecule to possess a dipole moment, the following condition is <u>necessary but not sufficient.</u>
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

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

Ans: A

Topic: Intermolecular forces

22. Which of these is the <u>weakest</u> of the intermolecular attractive forces?
A) Ion-ion
B) van der Waals
C) Dipole-dipole
D) Covalent bonding
E) Hydrogen bonding
Ans: B

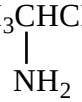
Topic: Functional groups

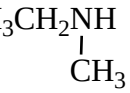
23. Which compound listed below is a secondary alcohol?
A) $CH_3CHCH_2CH_3$ (OH)
B) CH_3CHCH_2OH (CH_3)
C) CH_3COH (CH_3, CH_3)
D) $CH_3CH_2CH_2CH_2OH$
E) $CH_3CH_2CH_2OCH_3$
Ans: A

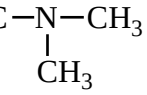
Topic: Functional groups

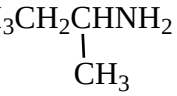
24. Which compound is a secondary amine?

A) $CH_3CH_2CH_2NH_2$

B) 

C) 

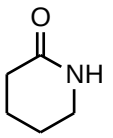
D) 

E) 

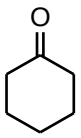
Ans: C

Topic: Functional groups

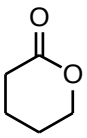
25. Which compound is an aldehyde?



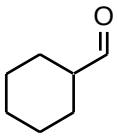
I



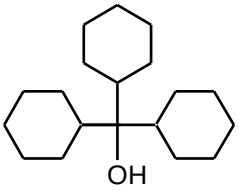
II



III



IV



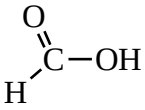
V

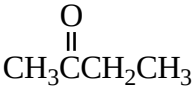
A) I
B) II
C) III
D) IV
E) V

Ans: D

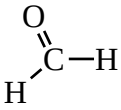
Topic: Functional groups

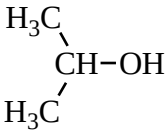
26. Which compound is a ketone?

A) 

B) 

C) 

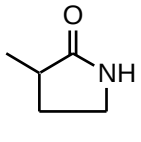
D) 

E) 

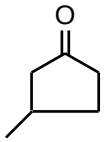
Ans: B

Topic: Functional groups

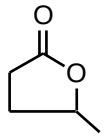
27. Which compound is an ester?



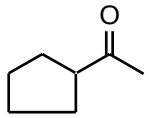
I



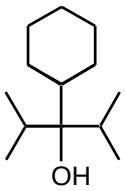
II



III



IV



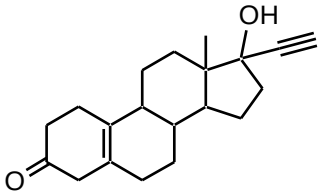
V

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

Ans: C

Topic: Functional groups

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



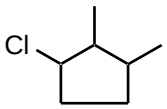
In addition to an alkane (actually cycloalkane) skeleton, the Enovid molecule also contains the following functional groups:

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.

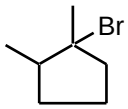
Ans: D

Topic: Functional Groups

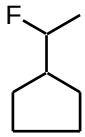
29. Which is a 3° alkyl halide?



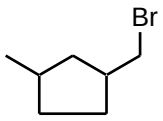
I



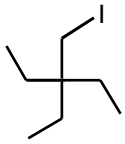
II



III



IV



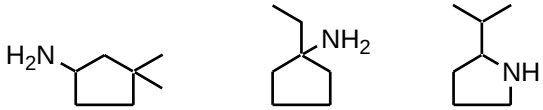
V

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

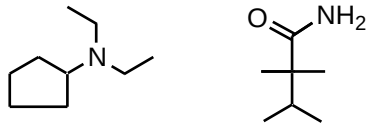
Ans: B

Topic: Functional groups

30. Which is a 3° amine?



I II III

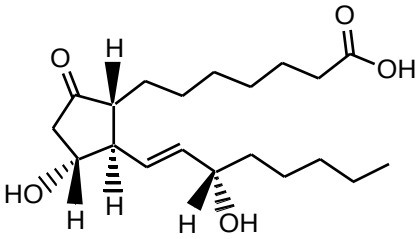


IV V

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

Topic: Functional groups

31. Which functional group is not contained in prostaglandin E_1?

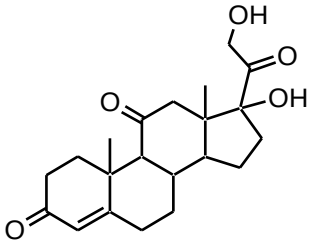


Prostaglandin E_1

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

Topic: Functional groups

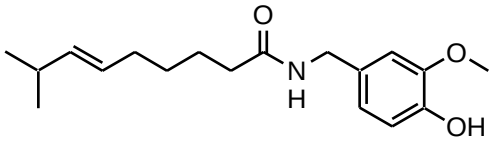
32. The compound below is an adrenocortical hormone called cortisone. Which functional group is not present in cortisone?



A) 1° alcohol
B) 2° alcohol
C) 3° alcohol
D) Ketone
E) Alkene
Ans: B

Topic: Functional groups

33. 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?

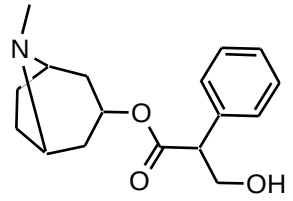


Capsaicin

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

34. 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?

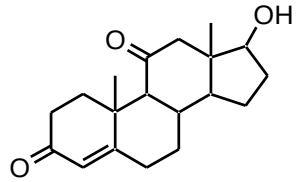


Atropine

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

Topic: Functional groups

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

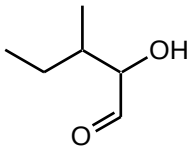


In addition to a cycloalkane skeleton, testosterone also contains the following functional groups:

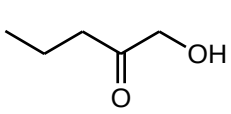
A) Alkene, ester, tertiary alcohol.
B) Alkene, ether, secondary alcohol.
C) Alkene, ketone, secondary alcohol.
D) Alkyne, ketone, secondary alcohol.
E) Alkene, ketone, tertiary alcohol.
Ans: C

Topic: Functional groups

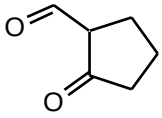
36. Which is a carboxylic acid?



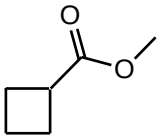
I



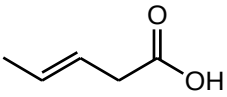
II



III



IV

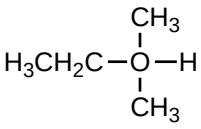


V

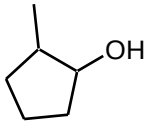
A) I
B) II
C) III
D) IV
E) V
Ans: E

Topic: Functional groups

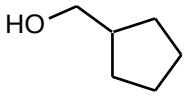
37. Which compound is a tertiary alcohol?



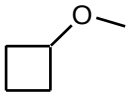
I



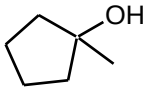
II



III



IV

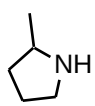


V

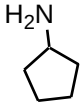
A) I
B) II
C) III
D) IV
E) V
Ans: E

Topic: Functional groups

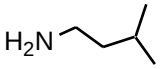
38. Which compound is a primary amine with the formula $C_5H_{13}N$?



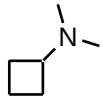
I



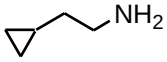
II



III



IV

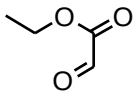


V

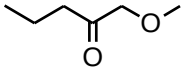
A) I
B) II
C) III
D) IV
E) V
Ans: C

Topic: Functional groups

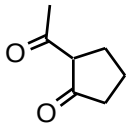
39. Which compound can be classified as an ester as well as a ketone?



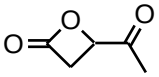
I



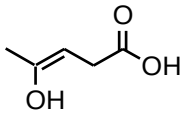
II



III



IV



V

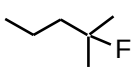
A) I
B) II
C) III
D) IV
E) V
Ans: D

Topic: Functional groups

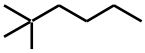
40. The C–O–C bond angle in diethyl ether is predicted to be approximately:
A) 90º
B) 105º
C) 110º
D) 120º
E) 180º
Ans: C

Topic: Functional groups

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

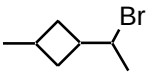


I

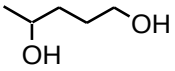


II

III



IV



V

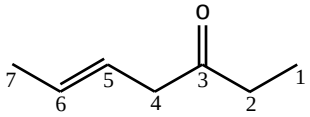
A) I, II, III
B) I
C) II, III
D) I, IV
E) V
Ans: D

Topic: Isomers

42. 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: General, Bonding

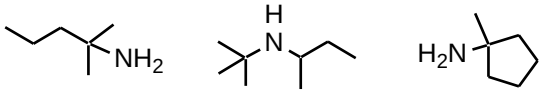
43. The C4-C5 carbon-carbon bond in the following molecule results from the overlap of which orbitals (in the order C4-C5) ?



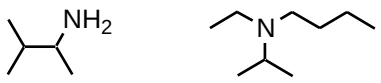
A) $sp–sp^2$
B) $sp–sp^3$
C) $sp^2–sp^2$
D) $sp^2–sp^3$
E) $sp^3–sp^2$
Ans: E

Topic: Functional groups

44. An example of a tertiary amine is:



I II III

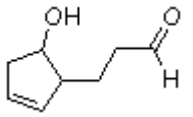


IV V

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

Topic: Functional groups

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



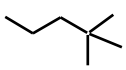
A) Alkene, 1º alcohol, ketone
B) Alkene, 2º alcohol, aldehyde
C) Alkene, 2º alcohol, ketone
D) Alkyne, 1º alcohol, aldehyde
E) Alkyne, 2º alcohol, ketone
Ans: B

Topic: Functional groups, Isomerism

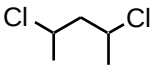
46. How many constitutional isomers are possible with the formula $C_4H_{10}O$?
A) 3
B) 4
C) 5
D) 6
E) 7
Ans: E

Topic: Functional groups

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

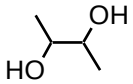


I



II

III



IV

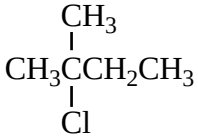
V

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

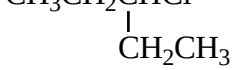
Topic: Functional groups

48. Which of these compounds is a secondary alkyl chloride?

A) $CH_3CH_2CH_2CH_2CH_2Cl$

B) 

C) 

D) 

E) Two of these

Ans: E

Topic: Functional groups, Isomerism

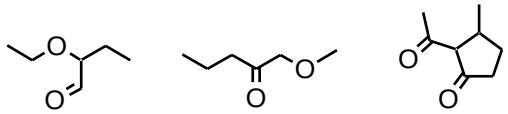
49. How many 2º alkyl bromides, neglecting stereoisomers, exist with the formula $C_6H_{13}Br$?

A) 4
B) 5
C) 6
D) 7
E) 8

Ans: C

Topic: Functional Groups

50. Many organic compounds contain more than one functional group. Which of the following is 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: IR Spectroscopy

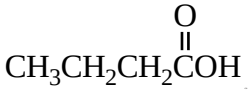
51. An oxygen-containing compound shows strong IR absorption at 1630-1780 cm^{-1} and 3200-3550 cm^{-1}. What type of compound is it likely to be?
A) An alcohol
B) A carboxylic acid
C) An ether
D) A ketone
E) An aldehyde
Ans: B

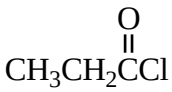
Topic: IR Spectroscopy

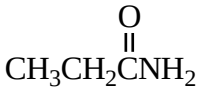
52. The absorption band for the O-H stretch in the IR spectrum of an alcohol is sharp and narrow in the case of:
A) a Nujol mull of the alcohol.
B) a concentrated solution of the alcohol.
C) a gas phase spectrum of the alcohol.
D) the spectrum of the neat liquid
E) none of these
Ans: C

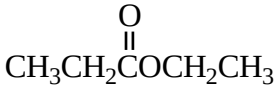
Topic: IR Spectroscopy

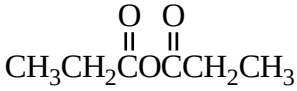
53. A split peak for the IR absorption due to bond stretching is observed for the carbonyl group in which of these compounds?

A) 

B) 

C) 

D) 

E) 

Ans: E

Topic: IR Spectroscopy

54. 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

55. The IR stretching frequency can be expected to occur at the lowest frequency for which of these bonds?

A) C–H
B) O–H
C) N–H
D) S–H
E) Difficult to predict

Ans: D

Topic: IR Spectroscopy

56. 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

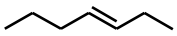
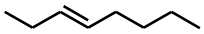
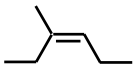
57. An anticipated IR absorption band may not be observed because:

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

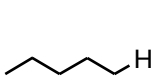
58. IR evidence for the presence of the C=C would be most difficult to detect in the case of which of these alkenes?

A) 
B) 
C) 
D) 
E) 

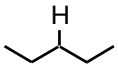
Ans: D

Topic: IR Spectroscopy

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

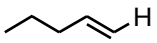


I

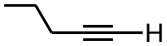


II

III



IV



V

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

Topic: IR Spectroscopy

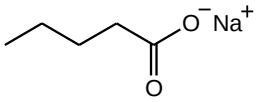
60. The IR spectrum of which type of compound will not show evidence of hydrogen bonding?
A) Aldehyde
B) Alcohol
C) Carboxylic acid
D) Phenol
E) Primary amine
Ans: A

Topic: IR Spectroscopy

61. 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: Intermolecular forces

62. 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

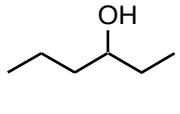
63. The IR stretching frequency occurs at the lowest frequency for which of these bonds?
A) B–H
B) O-H
C) N-H
D) S-H
E) Difficult to predict
Ans: D

Topic: IR Spectroscopy

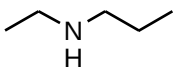
64. An oxygen-containing compound which shows sharp IR absorption at 2200 cm^{-1} and 3300 cm^{-1} is likely to be what type of compound?
A) An ester
B) An alkene
C) An alkyne
D) An ether
E) An aldehyde
Ans: B

Topic: IR Spectroscopy

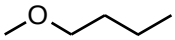
65. The IR spectrum of which of the following substances is likely to show a small, but sharp peak at 2200 cm^{-1}?



I

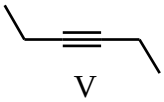


II



III

IV



V

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

SHORT ANSWER QUESTIONS

Topic: Functional Groups

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

Ans: alkenes

Topic: Functional Groups, IR Spectroscopy

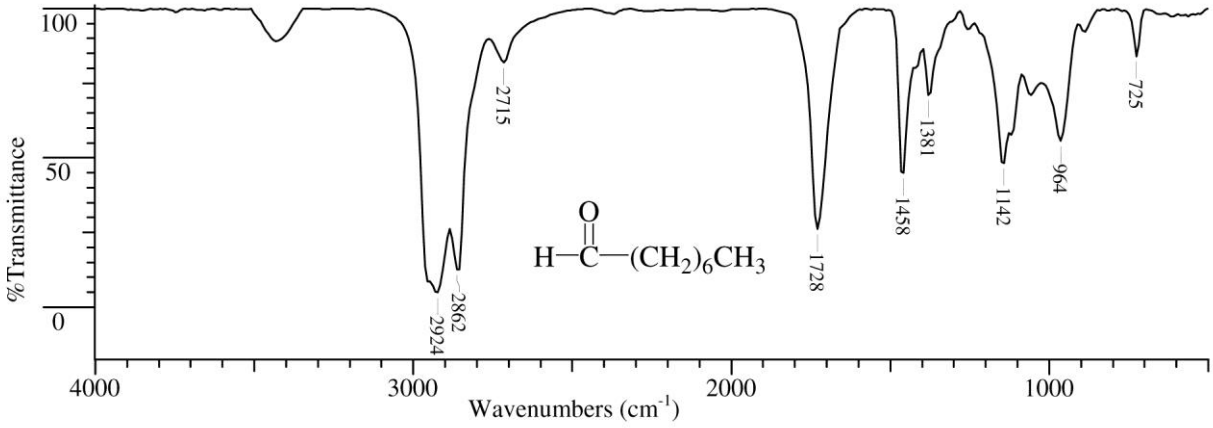
67. An IR spectrum has significant peaks at 2200 and 3300 cm^{-1}. What functional group is present in the molecule?
Ans: A terminal alkyne

Topic: Functional Groups

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

Topic: Functional Groups, IR Spectroscopy

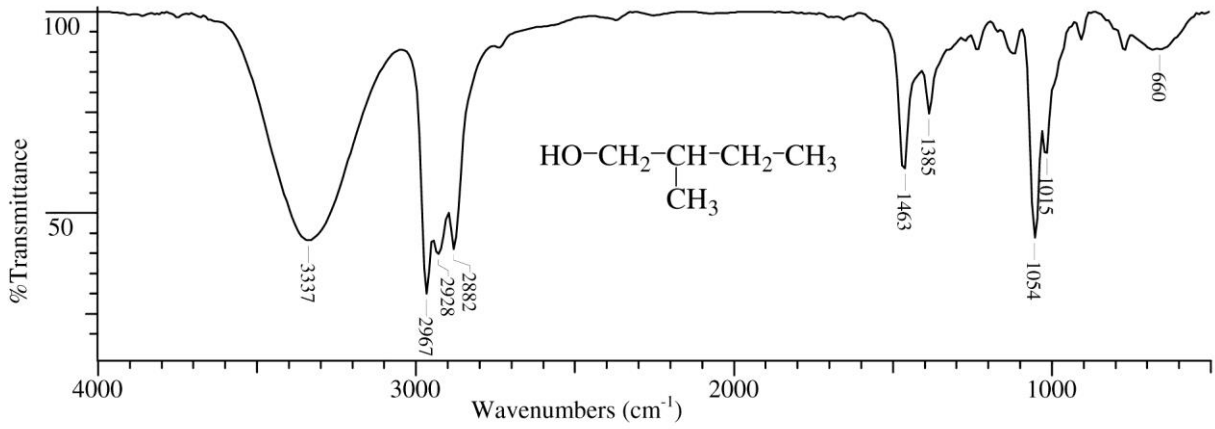
69. An IR spectrum has significant peaks at 3080 and 1650 cm^{-1}. What functional group is present in the molecule?



Ans: an alkene

Topic: Functional Groups, IR Spectroscopy

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



Ans: aldehyde

Topic: Functional Groups, IR Spectroscopy

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

Topic: General

72. 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: General

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

Topic: Functional Groups

74. 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: Functional Groups

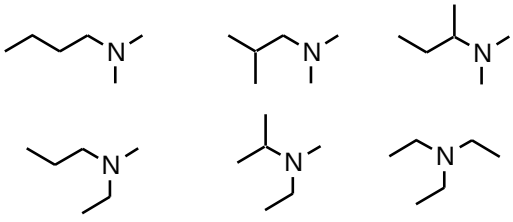
75. Unsaturated hydrocarbons may be distinguished from saturated hydrocarbons by the presence of one or more _____.
Ans: Pi bonds

Topic: Bonding, Solubility

76. 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.

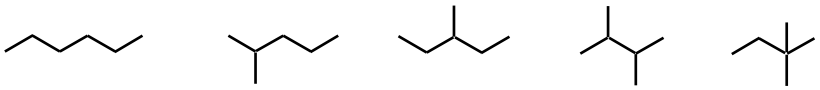
Topic: Isomers, Functional Groups

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



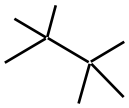
Topic: Isomers, Functional Groups

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



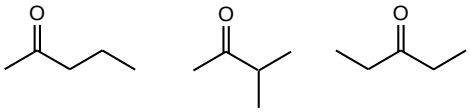
Topic: Isomers, Functional Groups

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



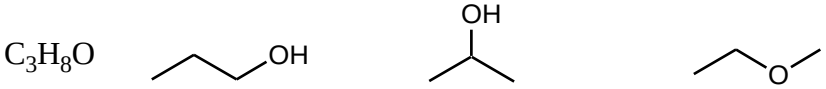
Topic: Isomers, Functional Groups

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



Topic: Isomers, Functional Groups

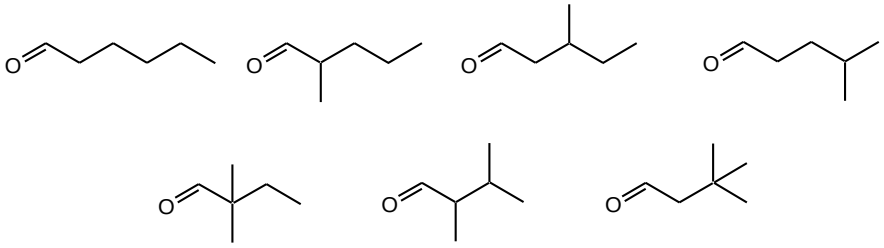
81. Draw all isomers of C_3H_8O and classify each according to functional group
Ans:



primary alcohol secondary alcohol ether

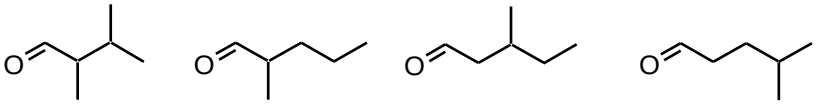
Topic: Isomers, Functional Groups

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



Topic: Isomers, Functional Groups

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

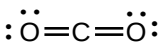


Topic: IR Spectroscopy

84. 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: Molecular Geometry, Dipole Moment

85. 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 Ans:wer.
    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: Intermolecular Forces

86. 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

87. 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: IR Spectroscopy

88. 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.