

# ***Organic Chemistry 12th edition Solomons Test Bank***

SKU: 9781118875766-TEST-BANK

Package title: Solomons Test Bank  
Course Title: Solomons 12e  
Chapter Number: 2

Question type: Multiple choice

1) Which of the following compounds contains polar covalent bonds?

- A)  $S_8$
- B)  $LiF$
- C)  $F_2$
- D)  $CH_3F$
- E) None of these choices.

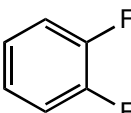
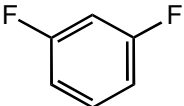
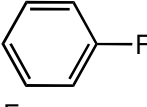
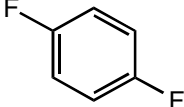
Answer: D

Topic: Polar Covalent Bonds

Section Reference 1: 2.2

Difficulty: Easy

2) Which molecule does not have a dipole moment?

- A)  A benzene ring with fluorine atoms at the 1 and 2 positions (ortho).
- B)  A benzene ring with fluorine atoms at the 1 and 3 positions (meta).
- C)  A benzene ring with fluorine atoms at the 1 and 4 positions (para).
- D)  A benzene ring with fluorine atoms at the 1, 2, and 4 positions.
- E) None of these choices.

Answer: D

Topic: Molecular geometry, polarity

Section Reference 1: 2.3

Difficulty: Easy

3) 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 choices.

Answer: C

Topic: Molecular geometry, polarity

Section Reference 1: 2.3

Difficulty: Easy

4) Which molecule has a zero dipole moment?

- A)  $\text{CH}_3\text{Cl}$
- B)  $\text{CH}_2\text{Cl}_2$
- C)  $\text{CHCl}_3$
- D)  $\text{CCl}_4$
- E) None of these choices.

Answer: D

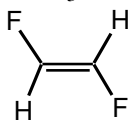
Topic: Molecular geometry, polarity

Section Reference 1: 2.3

Difficulty: Easy

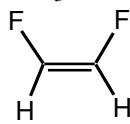
5) Which molecule would you expect to have no dipole moment (i.e.,  $\mu = 0 \text{ D}$ ) ?

- A)  $\text{CHF}_3$



- B)

- C)  $\text{:NF}_3$



- D)

- E)  $\text{CH}_2\text{F}_2$

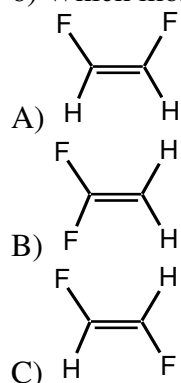
Answer: B

Topic: Molecular geometry, dipole moment

Section Reference 1: 2.3

Difficulty: Easy

6) Which molecule has a dipole moment greater than zero?



D) More than one of these choices.

E) None of these choices.

Answer: D

Topic: Molecular geometry, dipole moment

Section Reference 1: 2.3

Difficulty: Easy

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

A)  $\text{CBr}_4$

B) *cis*-1,2-Dibromoethene

C) *trans*-1,2-Dibromoethene

D) 1,1-Dibromoethene

E) More than one of these choices.

Answer: E

Topic: Molecular geometry, dipole moment

Section Reference 1: 2.3

Difficulty: Medium

8) 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

Answer: B

Topic: Molecular geometry, polarity

Section Reference 1: 2.3

Difficulty: Medium

9) Which molecule has a zero dipole moment?

- A)  $\text{SO}_2$
- B)  $\text{CO}_2$
- C)  $\text{CO}$
- D)  $\text{CHCl}_3$
- E) None of these choices.

Answer: B

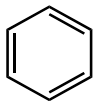
Topic: Molecular geometry, polarity

Section Reference 1: 1.5 and 2.3

Difficulty: Easy

10) Which molecule has a zero dipole moment?

- A)  $\text{CO}_2$
- B)  $\text{CH}_4$
- C)  $\text{CH}_3\text{CH}_3$



- E) All of these choices.

Answer: E

Topic: Molecular geometry, polarity

Section Reference 1: 1.5 and 2.3

Difficulty: Easy

11) Which molecule has a dipole moment of zero?

- A)  $\text{CHCl}_3$
- B)  $\text{CH}_2\text{Cl}_2$
- C)  $\text{ClHC}=\text{CH}_2$
- D) *trans*- $\text{ClHC}=\text{CHCl}$
- E) None of these choices.

Answer: D

Topic: Molecular geometry, polarity

Section Reference 1: 1.5 and 2.3

Difficulty: Medium

12) Which molecule would have a dipole moment greater than zero?

- A)  $\text{BeCl}_2$
- B)  $\text{BCl}_3$
- C)  $\text{CO}_2$
- D)  $\text{H}_2\text{O}$
- E)  $\text{CCl}_4$

Answer: D

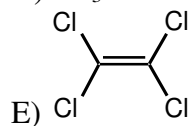
Topic: Molecular geometry, polarity

Section Reference 1: 1.5 and 2.3

Difficulty: Medium

13) A non-zero dipole moment is exhibited by:

- A)  $\text{SO}_2$
- B)  $\text{CO}_2$
- C)  $\text{CCl}_4$
- D)  $\text{BF}_3$



Answer: A

Topic: Molecular geometry, polarity

Section Reference 1: 1.5, 1.6 and 2.3

Difficulty: Medium

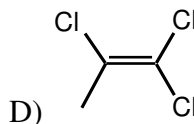
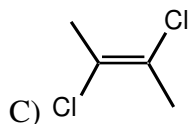
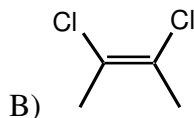
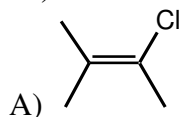
14) Of the following common organic solvents which one is predicted to have the smallest dipole moment?

- A) Chloroform,  $\text{CHCl}_3$
- B) Acetone,  $(\text{CH}_3)_2\text{CO}$
- C) Dimethylsulfoxide,  $(\text{CH}_3)_2\text{SO}$
- D) Acetonitrile,  $\text{CH}_3\text{CN}$
- E) Methanol,  $\text{CH}_3\text{OH}$

Answer: A

Topic: Molecular geometry, polarity  
Section Reference 1: 1.5, 1.6, and 2.3  
Difficulty: Hard

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

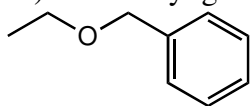


E) None of these choices have dipole moments equal to zero.

Answer: C

Topic: Molecular geometry, Polarity  
Section Reference 1: 2.3  
Difficulty: Easy

16) 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 choices.

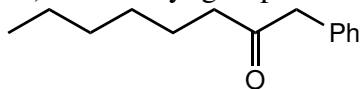
Answer: C

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Easy

17) What alkyl groups make up the following ketone?



- A) Phenyl, pentyl
- B) Hexyl, phenyl
- C) Benzyl, hexyl
- D) Benzyl, heptyl
- E) None of these choices.

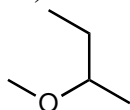
Answer: C

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Medium

18) 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 choices.

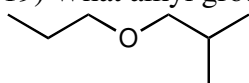
Answer: D

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Easy

19) 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 choices.

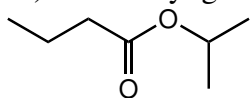
Answer: A

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Easy

20) 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 choices.

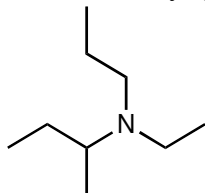
Answer: D

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Easy

21) What alkyl groups make up the following 3° amine?



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

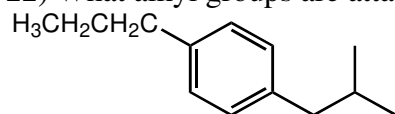
Answer: A

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Easy

22) What alkyl groups are attached to the benzene ring in the following example?



- A) ethyl, butyl
- B) ethyl, isobutyl
- C) propyl, *sec*-butyl
- D) propyl, butyl
- E) None of these choices.

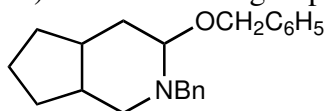
Answer: E

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Easy

23) 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 choices.

Answer: A

Topic: Functional groups

Section Reference 1: 2.4

Difficulty: Medium

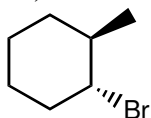
24) What group makes up the following aldehyde (benzaldehyde)?  
 $\text{C}_6\text{H}_5\text{CHO}$

- A) benzyl
- B) phenyl
- C) heptyl
- D) ethyl
- E) None of these choices.

Answer: B

Topic: Functional groups  
Section Reference 1: 2.4  
Difficulty: Medium

25) What functional group is present in the following compound?

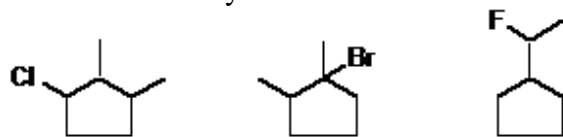


- A)  $1^\circ$  alkyl halide
- B)  $2^\circ$  alcohol
- C)  $2^\circ$  alkyl halide
- D)  $1^\circ$  amine
- E)  $3^\circ$  alkyl halide

Answer: C

Topic: Functional groups  
Section Reference 1: 2.5  
Difficulty: Easy

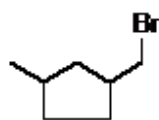
26) Which is a 3° alkyl halide?



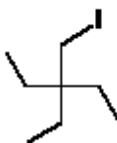
**I**

**II**

**III**



**IV**



**V**

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

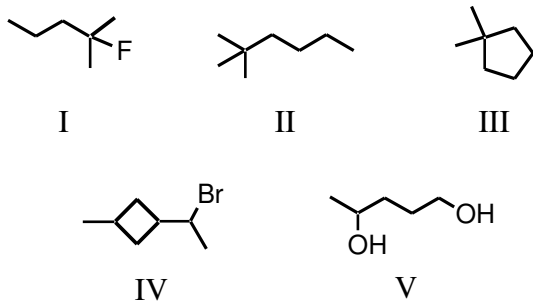
Answer: B

Topic: Functional Groups

Section Reference 1: 2.5

Difficulty: Easy

27) Which compound(s) contain(s) tertiary carbon atom(s) ?



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

Answer: D

Topic: Functional groups

Section Reference 1: 2.5

Difficulty: Medium

28) Which of these compounds is a secondary alkyl chloride?

- A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$
- B)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{CCH}_2\text{CH}_3 \\ | \\ \text{Cl} \end{array}$
- C)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{CHCH}_2\text{CH}_2\text{CH}_3 \\ | \\ \text{Cl} \end{array}$
- D)  $(\text{CH}_3)_2\text{CHCHClCH}_3$
- E) Two of these choices.

Answer: E

Topic: Functional groups

Section Reference 1: 2.5

Difficulty: Medium

29) How many 2° alkyl bromides, neglecting stereoisomers, exist with the formula  $C_6H_{13}Br$ ?

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

Answer: C

Topic: Functional groups, Isomerism

Section Reference 1: 1.6 and 2.5

Difficulty: Medium

30) 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

Answer: C

Topic: Isomers

Section Reference 1: 1.6 and 2.5

Difficulty: Medium

31) Which compound listed below is a secondary alcohol?

- A)  $\begin{array}{c} \text{CH}_3\text{CHCH}_2\text{CH}_3 \\ | \\ \text{OH} \end{array}$
- B)  $\begin{array}{c} \text{CH}_3\text{CHCH}_2\text{OH} \\ | \\ \text{CH}_3 \end{array}$
- C)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{COH} \\ | \\ \text{CH}_3 \end{array}$
- D)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- E)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_3$

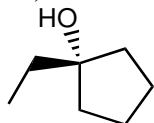
Answer: A

Topic: Functional groups

Section Reference 1: 2.6

Difficulty: Easy

32) What functional group is present in the following compound?



- A) 1° alcohol
- B) ether
- C) 2° alcohol
- D) ester
- E) 3° alcohol

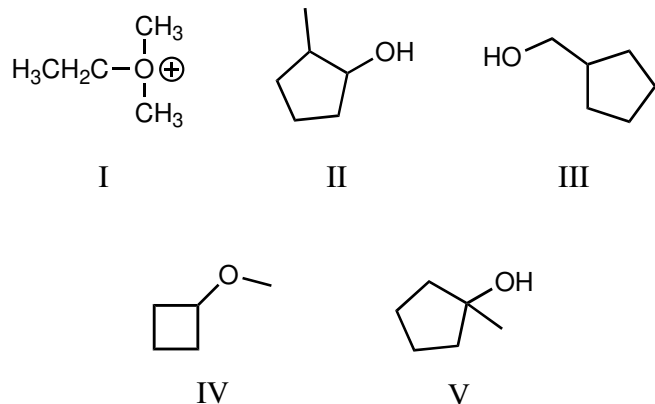
Answer: E

Topic: Functional groups

Section Reference 1: 2.6

Difficulty: Easy

33) Which compound is a tertiary alcohol?



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

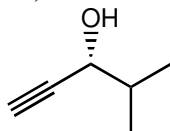
Answer: E

Topic: Functional groups

Section Reference 1: 2.6

Difficulty: Medium

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



- A) alkyne and 2° alcohol
- B) alkyne and 1° alcohol
- C) 2° alcohol and alkene
- D) nitrile and 1° alcohol
- E) alkene and 2° alcohol

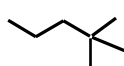
Answer: A

Topic: Functional groups

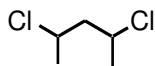
Section Reference 1: 2.1 and 2.6

Difficulty: Easy

35) A tertiary carbon atom is present in which of these compounds?



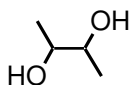
I



II



III



IV



V

- A) I
- B) II, IV
- C) III, V
- D) IV
- E) All of these choices.

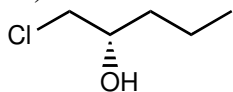
Answer: C

Topic: Functional groups

Section Reference 1: 2.5 and 2.6

Difficulty: Easy

36) 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 choices.

Answer: D

Topic: Functional groups

Section Reference 1: 2.5 and 2.6

Difficulty: Easy

37) How many constitutional isomers are possible with the formula  $C_4H_{10}O$ ?

- A) 3
- B) 4
- C) 5
- D) 6
- E) 7

Answer: E

Topic: Functional groups, Isomerism

Section Reference 1: 1.3, 2.6, and 2.7

Difficulty: Easy

38) Which compound is a secondary amine?

- A)  $CH_3CH_2CH_2NH_2$   
 $CH_3CHCH_3$   
|  
 $NH_2$
- B)  $CH_3CH_2NH$   
|  
 $CH_3$
- C)  $H_3C-N-CH_3$   
|  
 $CH_3$
- D)  $CH_3CH_2CHNH_2$   
|  
 $CH_3$
- E)  $CH_3CH_2CH_2NH_2$

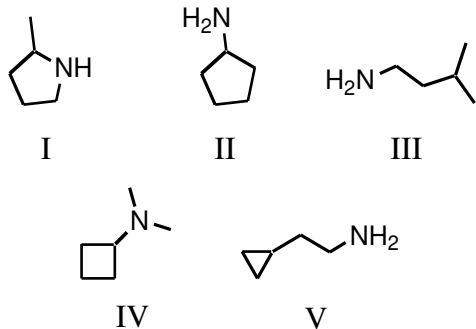
Answer: C

Topic: Functional groups

Section Reference 1: 2.8

Difficulty: Easy

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



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

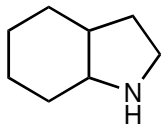
Answer: C

Topic: Functional groups

Section Reference 1: 2.8

Difficulty: Easy

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



- A)  $1^\circ$  alkyl bromide
- B)  $2^\circ$  amine
- C) nitrile
- D)  $1^\circ$  amine
- E)  $3^\circ$  amine

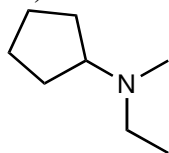
Answer: B

Topic: Functional groups

Section Reference 1: 2.8

Difficulty: Easy

41) What functional group is present in the following compound?



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

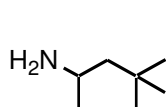
Answer: E

Topic: Functional groups

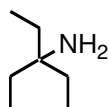
Section Reference 1: 2.8

Difficulty: Easy

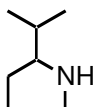
42) Which is a 3° amine?



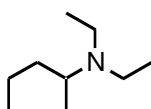
I



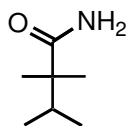
II



III



IV



V

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

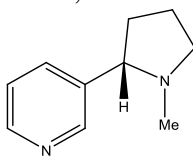
Answer: D

Topic: Functional groups

Section Reference 1: 2.8

Difficulty: Easy

43) What functional groups are present in nicotine, an addictive substance found in tobacco?



- A) two tertiary amines
- B) two secondary amines
- C) phenyl ring and tertiary amine
- D) secondary and tertiary amine
- E) none of these choices

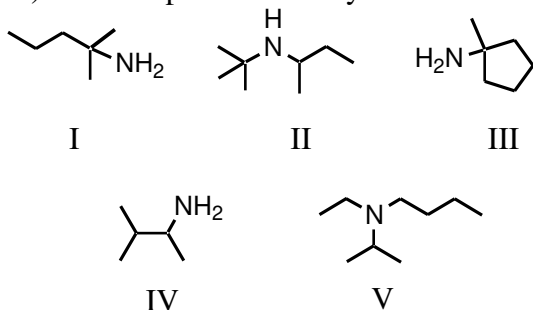
Answer: A

Topic: Functional groups

Section Reference 1: 2.8

Difficulty: Easy

44) An example of a tertiary amine is:



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

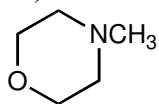
Answer: E

Topic: Functional groups

Section Reference 1: 2.8

Difficulty: Easy

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



- A) ether and 2° amine
- B) ester and 3° amine
- C) 3° amine
- D) 3° amine and ether
- E) None of these choices.

Answer: D

Topic: Functional groups

Section Reference 1: 2.7 and 2.8

Difficulty: Easy

46) Which compound is a ketone?

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

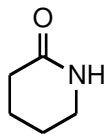
Answer: B

Topic: Functional groups

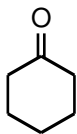
Section Reference 1: 2.9

Difficulty: Easy

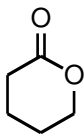
47) Which compound is an aldehyde?



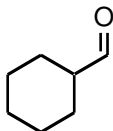
I



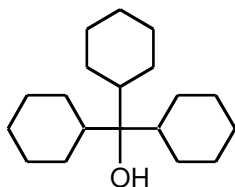
II



III



IV



V

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

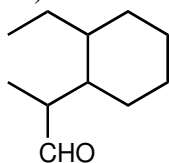
Answer: D

Topic: Functional groups

Section Reference 1: 2.9

Difficulty: Easy

48) What functional group is present in the following compound?



- A) alcohol
- B) ketone
- C) aldehyde
- D) ester
- E) ether

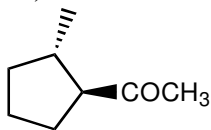
Answer: C

Topic: Functional groups

Section Reference 1: 2.9

Difficulty: Medium

49) What functional group is present in the following compound?



- A) alcohol
- B) ketone
- C) aldehyde
- D) ester
- E) ether

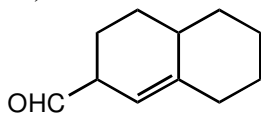
Answer: B

Topic: Functional groups

Section Reference 1: 2.9

Difficulty: Medium

50) 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° alcohol and alkene

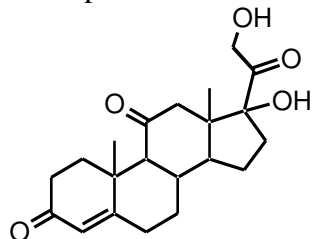
Answer: C

Topic: Functional groups

Section Reference 1: 2.1 and 2.9

Difficulty: Medium

51) 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

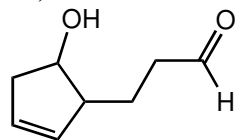
Answer: D

Topic: Functional groups

Section Reference 1: 2.1, 2.6, and 2.9

Difficulty: Easy

52) Which functional groups are present in the following compound?



- A) Alkene, 1° alcohol, ketone
- B) Alkene, 2° alcohol, aldehyde
- C) Alkene, 2° alcohol, ketone
- D) Alkyne, 1° alcohol, aldehyde
- E) Alkyne, 2° alcohol, ketone

Answer: B

Topic: Functional groups

Section Reference 1: 2.1, 2.6, and 2.9

Difficulty: Easy

53) 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

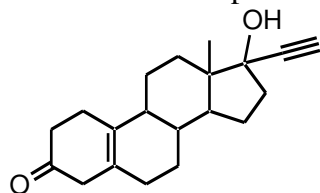
Answer: C

Topic: Functional groups

Section Reference 1: 2.1, 2.6, and 2.9

Difficulty: Easy

54) The compound shown below is norethyndrel, a synthetic estrogen. It was marketed in the first oral contraceptive under the name Enovid.



In addition to an alkane (actually cycloalkane) skeleton, the norethyndrel 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

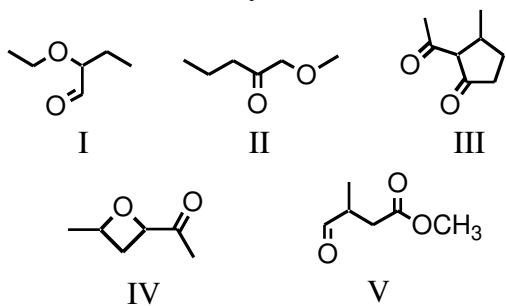
Answer: D

Topic: Functional groups

Section Reference 1: 2.1, 2.6, and 2.9

Difficulty: Medium

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

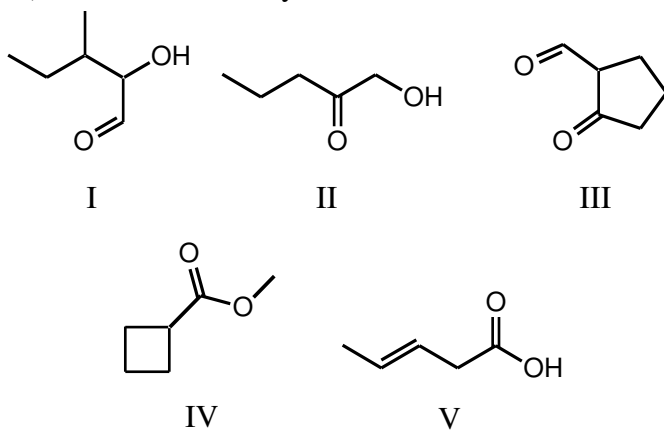


- A) I
- B) II, IV
- C) V
- D) I, V
- E) III

Answer: A

Topic: Functional Groups  
Section Reference 1: 2.7 and 2.9  
Difficulty: Easy

56) Which is a carboxylic acid?

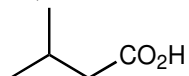


- A) I
- B) II
- C) III
- D) IV
- E) V

Answer: E

Topic: Functional groups  
Section Reference 1: 2.10  
Difficulty: Easy

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

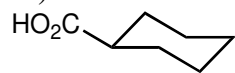


- A) 1° alcohol and ketone
- B) carboxylic acid
- C) ester
- D) 1° alcohol and aldehyde
- E) alcohol

Answer: B

Topic: Functional groups  
Section Reference 1: 2.10  
Difficulty: Medium

58) 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

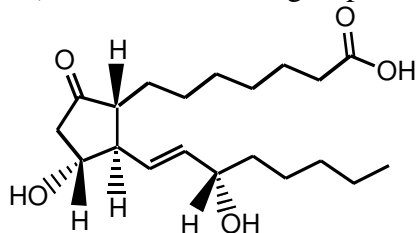
Answer: C

Topic: Functional groups

Section Reference 1: 2.10

Difficulty: Medium

59) Which functional group is *not* contained in prostaglandin E<sub>1</sub>?



Prostaglandin E<sub>1</sub>

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

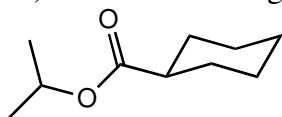
Answer: C

Topic: Functional groups

Section Reference 1: 2.1, 2.6, 2.9, and 2.10

Difficulty: Medium

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

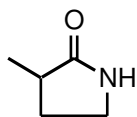


- A) ether and ketone
- B) carbonyl and ether
- C) carboxylic acid and ether
- D) ester
- E) 1° alcohol

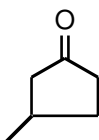
Answer: D

Topic: Functional groups  
Section Reference 1: 2.10  
Difficulty: Easy

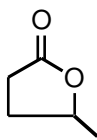
61) Which compound is an ester?



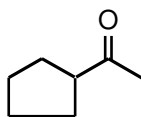
I



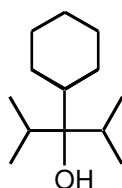
II



III



IV



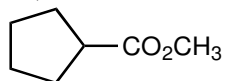
V

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

Answer: C

Topic: Functional groups  
Section Reference 1: 2.10  
Difficulty: Easy

62) What functional group is present in the following compound?

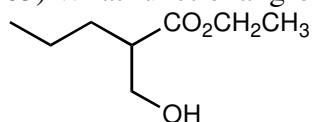


- A) alcohol
- B) ketone
- C) aldehyde
- D) ester
- E) ether

Answer: D

Topic: Functional groups  
Section Reference 1: 2.10  
Difficulty: Medium

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

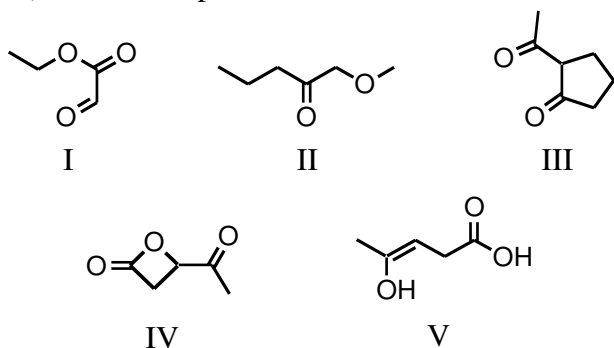


- A) Ketone and 1° alcohol
- B) Ether and alcohol
- C) Ester and ether
- D) Ester and 1° alcohol
- E) 1° alcohol and aldehyde

Answer: D

Topic: Functional groups  
Section Reference 1: 2.6 and 2.10  
Difficulty: Medium

64) Which compound can be classified as an ester as well as a ketone?



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

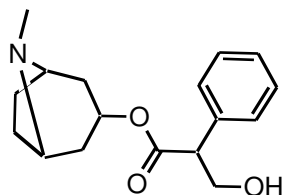
Answer: D

Topic: Functional groups

Section Reference 1: 2.9 and 2.10

Difficulty: Medium

65) 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

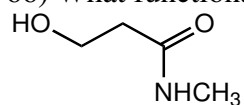
Answer: E

Topic: Functional groups

Section Reference 1: 2.1, 2.6, 2.8, and 2.10

Difficulty: Hard

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



- A) 1° alcohol and 2° amine
- B) amide and 2° alcohol
- C) nitrile and 1° alcohol
- D) 2° amide and ether
- E) None of these choices.

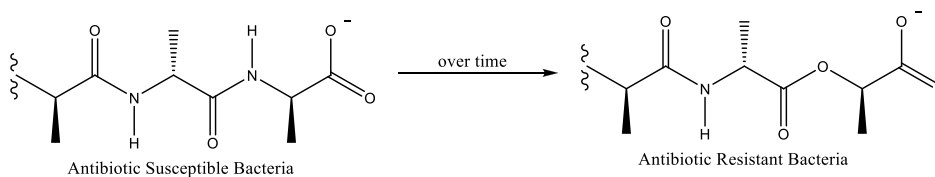
Answer: E

Topic: Functional groups

Section Reference 1: 2.6 and 2.10

Difficulty: Medium

67) Many bacterial cells contain functional groups that are susceptible to antibiotic drugs, but may, over time, change their functional groups to become resistant to these drugs. What functional group change is occurring in the transition shown below?



- A) Amine to ether
- B) Amine to ester
- C) Amide to ester
- D) Amide to ether
- E) None of these choices.

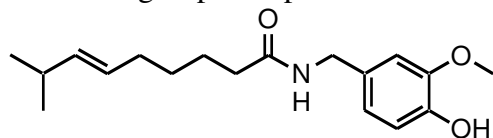
Answer: C

Topic: Functional Groups

Section Reference 1: 2.10

Difficulty: Medium

68) 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

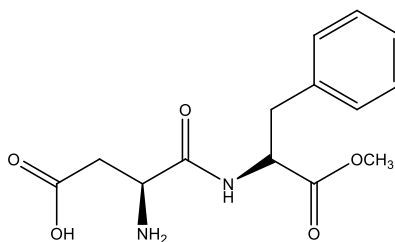
Answer: D

Topic: Functional groups

Section Reference 1: 2.1, 2.6, 2.7, and 2.10

Difficulty: Medium

69) The compound aspartame is a dipeptide that is often used as a sugar substitute. Which functional groups are present in aspartame?



- A) carboxylic acid, secondary amine, ketone, ester
- B) alcohol, secondary amine, ketone, ester
- C) carboxylic acid, ester, amide, secondary amine
- D) ester, amide, primary amine, carboxylic acid
- E) none of these choices

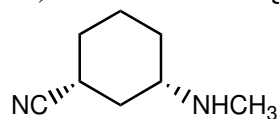
Answer: D

Topic: Functional groups

Section Reference 1: 2.1, 2.6, 2.7, and 2.10

Difficulty: Medium

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



- A) 1° amine and 2° amine
- B) amide and 2° amine
- C) 2° amine and nitrile
- D) nitrile and 1° amine
- E) amide and nitrile

Answer: C

Topic: Functional groups

Section Reference 1: 2.8 and 2.11

Difficulty: Medium

71) The *strongest* of attractive forces is which type?

- A) Dispersion forces
- B) Ion-dipole
- C) Dipole-dipole
- D) Cation-anion
- E) Hydrogen bonds

Answer: D

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

72) Which of these is the *weakest* of the intermolecular attractive forces taken individually?

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

Answer: B

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

73) 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

Answer: D

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

74) Which of the following is not found in the following substance?



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

Answer: A

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

75) Which alkane is predicted to have the highest melting point of those shown?

- A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$   
     $\text{CH}_3\text{CHCH}_3$   
      |  
       $\text{CH}_3$
- B)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$   
     $\text{CH}_3\text{CHCH}_2\text{CH}_3$   
      |  
       $\text{CH}_3$
- C)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$   
     $\text{CH}_3\text{CHCH}_2\text{CH}_3$   
      |  
       $\text{CH}_3$
- D)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$   
     $\text{CH}_3\text{CHCH}_2\text{CH}_3$   
      |  
       $\text{CH}_3$
- E)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$   
     $\text{CH}_3\text{CHCH}_2\text{CH}_3$   
      |  
       $\text{CH}_3$

Answer: E

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

76) What intermolecular forces hold base pairs together in DNA?

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

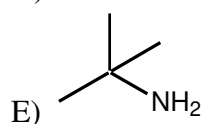
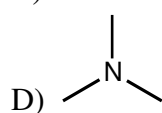
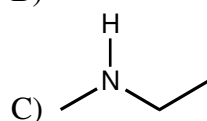
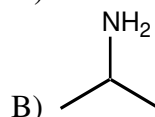
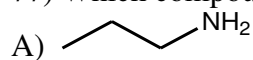
Answer: C

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

77) Which compound would you expect to have the lowest boiling point?



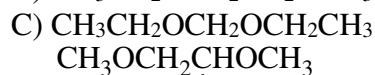
Answer: D

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

78) Which of these compounds would have the highest boiling point?



Answer: E

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

79) Which compound would have the highest boiling point?

- A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- B)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_3$
- C)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- D)  $\text{CH}_3\text{CH}_2\text{OCH}(\text{CH}_3)_2$
- E)  $\text{CH}_3\text{OCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

Answer: C

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

80) Of the following compounds, the one with the highest boiling point is:

- A)  $\text{CH}_3\text{CH}_3$
- B)  $\text{CH}_3\text{CH}_2\text{Cl}$
- C)  $\begin{array}{c} \text{CH}_3\text{C}=\text{O} \\ | \\ \text{H} \end{array}$
- D)  $\text{CH}_3\text{CH}_2\text{OH}$
- E)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$

Answer: D

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

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

- A) ethane
- B) ethene
- C) ethyne
- D) bromoethane
- E) methane

Answer: D

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

82) Which compound would you expect to have the highest boiling point?

- A) ethyl alcohol
- B) ethyl amine
- C) chloroethane
- D) water
- E) ethane

Answer: D

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

83) Which of these would you expect to have the lowest boiling point?

- A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- B)  $\begin{array}{c} \text{CH}_3\text{CHCH}_3 \\ | \\ \text{OH} \end{array}$
- C)  $\text{CH}_3\text{OCH}_2\text{CH}_3$
- D)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- E)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$

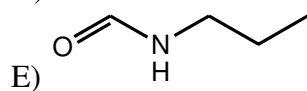
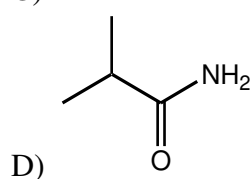
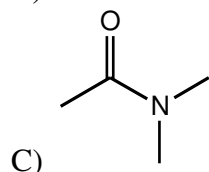
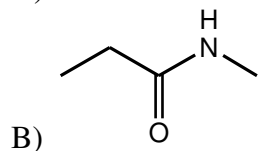
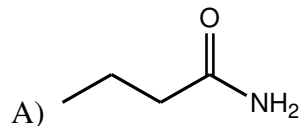
Answer: C

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

84) Which compound would you expect to have the lowest boiling point?



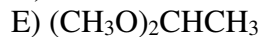
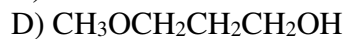
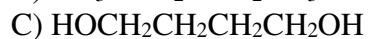
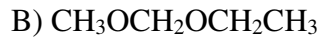
Answer: C

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

85) Which compound would you expect to have the highest boiling point?



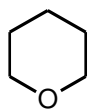
Answer: C

Topic: Intermolecular forces

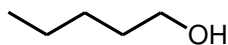
Section Reference 1: 2.13

Difficulty: Medium

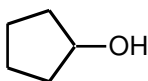
86) Which compound would have the lowest boiling point?



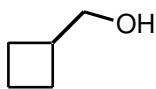
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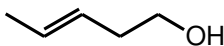
II



III



IV



V

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

Answer: A

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Medium

87) The solid alkane  $\text{CH}_3(\text{CH}_2)_{18}\text{CH}_3$  is expected to exhibit the greatest solubility in which of the following solvents?

- A)  $\text{CCl}_4$
- B)  $\text{CH}_3\text{OH}$
- C)  $\text{H}_2\text{O}$
- D)  $\text{CH}_3\text{NH}_2$
- E)  $\text{HOCH}_2\text{CH}_2\text{OH}$

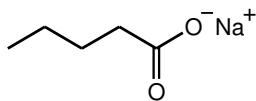
Answer: A

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

88) The following substance is expected to have the lowest solubility in which of the following solvent(s) ?



- A)  $\text{CCl}_4$
- B)  $\text{C}_2\text{H}_5\text{OH}$
- C)  $\text{CHCl}_3$
- D)  $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- E) The given substance is likely to be quite soluble in all of the solvents described.

Answer: A

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

89) The compound NaOH is barely soluble in ethanol. The addition of which of the following solvents to ethanol would greatly increase the solubility of NaOH?

- A)  $\text{H}_2\text{O}$
- B)  $\text{Et}_2\text{O}$
- C)  $\text{CH}_2\text{Cl}_2$
- D) Benzene
- E) All of these choices.

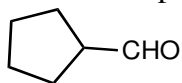
Answer: A

Topic: Intermolecular forces

Section Reference 1: 2.13

Difficulty: Easy

90) 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  $1700\text{ cm}^{-1}$
- B) a peak around  $3300\text{ cm}^{-1}$
- C) only normal alkane absorptions
- D) a peak around  $2250\text{ cm}^{-1}$
- E) None of these choices.

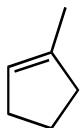
Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Easy

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  $1700\text{ cm}^{-1}$
- B) a peak around  $3300\text{ cm}^{-1}$
- C) a peak around  $1650\text{ cm}^{-1}$
- D) a peak around  $2250\text{ cm}^{-1}$
- E) None of these choices.

Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Easy

92) 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

Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Easy

93) 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

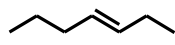
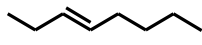
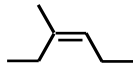
Answer: B

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Easy

94) 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) 

Answer: D

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Easy

95) An oxygen-containing compound shows strong IR absorption at  $1630\text{--}1780\text{ cm}^{-1}$  and  $3200\text{--}3550\text{ cm}^{-1}$ . 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

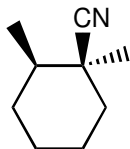
Answer: B

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

96) 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  $1700\text{ cm}^{-1}$
- B) a peak around  $3300\text{ cm}^{-1}$
- C) a peak around  $1650\text{ cm}^{-1}$
- D) a peak around  $2250\text{ cm}^{-1}$
- E) None of these choices.

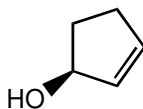
Answer: D

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

97) 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  $1650\text{ cm}^{-1}$
- B) peaks around  $3300$  and  $1710\text{ cm}^{-1}$
- C) peaks around  $1650$  and  $3300\text{ cm}^{-1}$
- D) only a peak around  $3300\text{ cm}^{-1}$
- E) None of these choices.

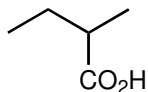
Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

98) 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  $\text{cm}^{-1}$
- B) a strong broad peak over 3600 to 2500 and around 1710  $\text{cm}^{-1}$
- C) peaks around 1650 and 3300  $\text{cm}^{-1}$
- D) peaks around 3300 and 1710  $\text{cm}^{-1}$
- E) None of these choices.

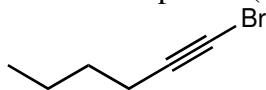
Answer: B

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

99) 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  $\text{cm}^{-1}$
- B) a strong broad peak over 3600 to 2500  $\text{cm}^{-1}$
- C) peaks around 1650 and 3300  $\text{cm}^{-1}$
- D) a peak around 1710  $\text{cm}^{-1}$
- E) None of these choices.

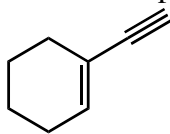
Answer: E

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

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 3300, 2150, and 1650  $\text{cm}^{-1}$
- B) peaks around 1710 and 1650  $\text{cm}^{-1}$
- C) peaks around 1650 and 3300  $\text{cm}^{-1}$
- D) a peak around 2250 and 3300  $\text{cm}^{-1}$
- E) None of these choices.

Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

101) 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 choices.

Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

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

- A)  $\text{CH}_3\text{CH}_2\text{CH}_2\overset{\text{O}}{\parallel}\text{COH}$
- B)  $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{CCl}$
- C)  $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{CH}$
- D)  $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{COCH}_2\text{CH}_3$
- E)  $\text{CH}_3\text{CH}_2\overset{\text{O}}{\parallel}\text{COC}\overset{\text{O}}{\parallel}\text{CH}_2\text{CH}_3$

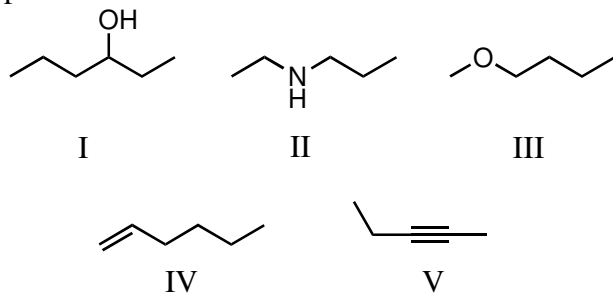
Answer: E

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

103) The IR spectrum of which of the following substances is likely to show a small, but sharp peak at  $2200\text{ cm}^{-1}$ ?



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

Answer: E

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

104) 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 choices.

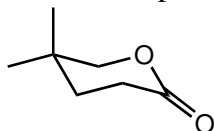
Answer: E

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

105) 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  $\text{cm}^{-1}$
- B) a strong broad peak over 3600 to 2500  $\text{cm}^{-1}$
- C) peaks around 1650 and 3300  $\text{cm}^{-1}$
- D) a peak around 1740  $\text{cm}^{-1}$
- E) None of these choices.

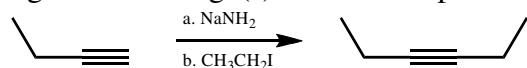
Answer: D

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

106) 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  $1710\text{ cm}^{-1}$  would disappear.
- B) A peak around  $1710\text{ cm}^{-1}$  would appear.
- C) A peak around  $2150\text{ cm}^{-1}$  would disappear.
- D) No change would be observed.
- E) None of these choices.

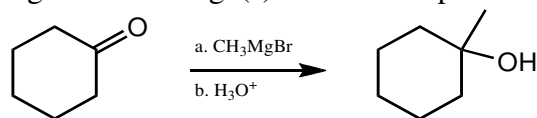
Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

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

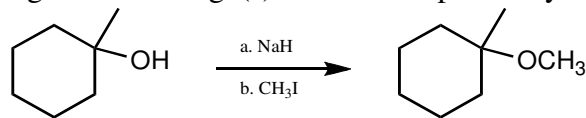
Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

108) 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  $3300\text{ cm}^{-1}$  would disappear.
- B) A peak around  $1710\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- C) A peak around  $2150\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- D) No change would be observed.
- E) None of these choices.

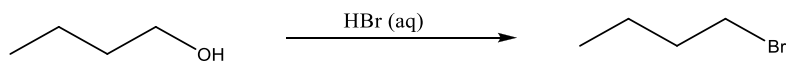
Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

109) 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  $3300\text{ cm}^{-1}$  would disappear.
- B) A peak around  $1710\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- C) A peak around  $2150\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- D) No change would be observed.
- E) None of these choices.

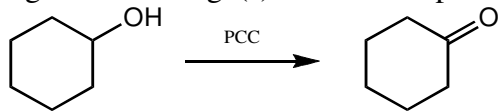
Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

110) 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  $3300\text{ cm}^{-1}$  would disappear and nothing new would appear.
- B) A new peak around  $1710\text{ cm}^{-1}$  would appear and a peak around  $3300\text{ cm}^{-1}$  would disappear.
- C) A peak around  $2150\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- D) No change would be observed.
- E) None of these choices.

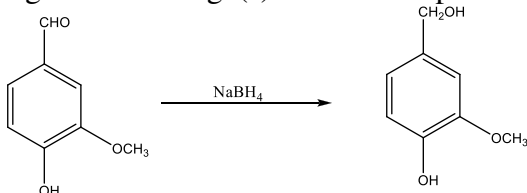
Answer: B

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

111) 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  $3300\text{ cm}^{-1}$  would appear and nothing new would appear.
- B) A peak around  $1710\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- C) A peak around  $2150\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- D) No change would be observed.
- E) None of these choices.

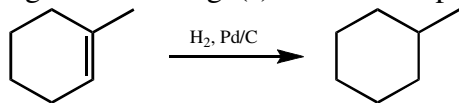
Answer: E

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

112) 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  $3300\text{ cm}^{-1}$  would disappear and nothing new would appear.
- B) A peak around  $1710\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- C) A peak around  $1650\text{ cm}^{-1}$  would disappear and nothing new would appear.
- D) No change would be observed.
- E) None of these choices.

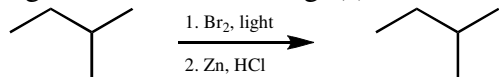
Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

113) 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  $3300\text{ cm}^{-1}$  would disappear and nothing new would appear.
- B) A peak around  $1710\text{ cm}^{-1}$  would disappear and a new peak around  $3300\text{ cm}^{-1}$  would appear.
- C) A peak around  $1650\text{ cm}^{-1}$  would disappear and nothing new would appear.
- D) No overall change would be observed.
- E) None of these choices.

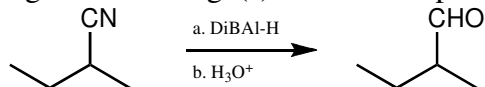
Answer: D

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

114) 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<sup>-1</sup> would disappear and nothing new would appear.
- B) A peak around 1720 cm<sup>-1</sup> would disappear and a new peak around 3300 cm<sup>-1</sup> would appear.
- C) A peak around 2250 cm<sup>-1</sup> would disappear and a new peak around 1720 cm<sup>-1</sup> would appear.
- D) A peak around 2250 cm<sup>-1</sup> would disappear and a new peak around 3300 cm<sup>-1</sup> would appear.
- E) No change would be observed.

Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

115) 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

Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

116) 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

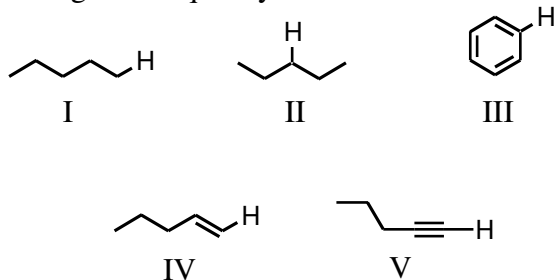
Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

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



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

Answer: E

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

118) An oxygen-containing compound which shows sharp IR absorption at  $2200\text{ cm}^{-1}$  and  $3300\text{ cm}^{-1}$  is likely to contain which functional group?

- A) An ester
- B) An alkene
- C) An alkyne
- D) An ether
- E) An aldehyde

Answer: C

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

119) *n*-Pentane has a higher boiling point than isopentane due to an increased surface-to-surface interaction of dispersion forces.

- A) True
- B) False

Answer: A

Topic: Intermolecular Forces

Section Reference 1: 2.13

Difficulty: Easy

120) Carbon dioxide has a higher boiling point than carbon disulfide due to its dipole-dipole forces.

- A) True
- B) False

Answer: B

Topic: Intermolecular Forces

Section 2.13

Difficulty: Medium

121) Even though methyl amine ( $\text{CH}_3\text{NH}_2$ ) has a higher molecular weight than water ( $\text{H}_2\text{O}$ ), its boiling point is much lower than water's boiling point since water has hydrogen bonding attractive forces.

- A) True
- B) False

Answer: B

Topic: Intermolecular Forces

Section Reference 1: 2.13

Difficulty: Hard

122) Hydrogen bonding will broaden the O–H absorption band in an infrared spectrum.

- A) True
- B) False

Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Easy

123) The higher the wave number in the infrared spectra, the greater the energy that is required to vibrate the bond.

- A) True
- B) False

Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

124) The molecule  $\text{N}_2$  does not show an absorption in an IR spectrum because the dipole moment of the molecule does not change with the absorption of IR energy.

- A) True
- B) False

Answer: A

Topic: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Hard

125) Hydrocarbons containing carbon-carbon double bonds are referred to as \_\_\_\_.

Answer: alkenes

Topic: Functional Groups

Section Reference 1: 2.1

Difficulty: Easy

126) All of the carbon-carbon bonds in \_\_\_\_ are equal to one and one-half bonds and have a bond length in between that of a single bond and a double bond with all of the bond angles at \_\_\_\_.

Answer: benzene,  $120^\circ$

Topic: Functional Groups

Section Reference 1: 2.1

Difficulty: Easy

127) Unsaturated hydrocarbons may be distinguished from saturated hydrocarbons by the presence of one or more \_\_\_\_.

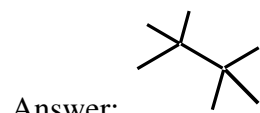
Answer: pi bonds

Topic: Functional Groups

Section Reference 1: 2.1

Difficulty: Easy

128) Draw a structural formula for  $C_8H_{18}$ , in which there are two quaternary carbons.



Topic: Isomers, Functional Groups

Section Reference 1: 2.1

Difficulty: Easy

129) The six  $p$  electrons in benzene are \_\_\_\_ about the ring, which explains why all of the C-C bonds are the same length.

Answer: delocalized

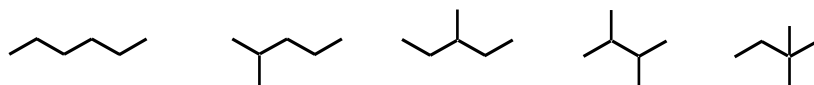
Topic: General

Section Reference 1: 2.1

Difficulty: Easy

130) Draw all isomers of  $C_6H_{14}$ .

Answer:



Topic: Isomers, Functional Groups

Section Reference 1: 1.3A and 2.1

Difficulty: Easy

131) A polar covalent bond is one in which electrons are \_\_\_\_.

Answer: not shared equally

Topic: General

Section Reference 1: 2.2

Difficulty: Easy

132) The \_\_\_\_ is defined as the product of the magnitude of the charge of a particle and the distance that separates them.

Answer: dipole moment

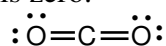
Topic: Polar Covalent Bond

Section Reference 1: 2.2

Difficulty: Easy

133) 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.

Answer: 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.



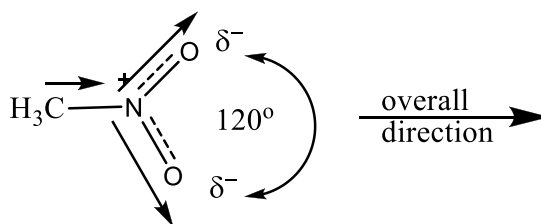
Topic: Molecular Geometry, Dipole Moment

Section Reference 1: 2.2 and 2.3

Difficulty: Medium

134) Nitromethane is a polar molecule but contains 2 equal polar covalent bonds. Briefly explain why and draw a relevant 3-dimensional structure to show the overall dipole moment of the molecule.

Answer: The nitro group has 2 polar N-O bonds that are pointing  $120^\circ$  apart which do not completely cancel out and the C-N bond is polar as well which further adds to the net direction of the dipole.



Topic: Molecular Geometry, Dipole Moment

Section Reference 1: 2.2 and 2.3

Difficulty: Medium

135) 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 \_\_\_\_.

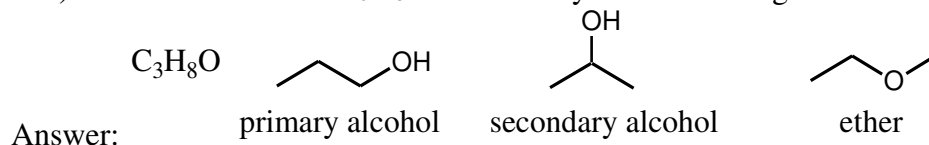
Answer: functional groups

Topic: Functional Groups

Section Reference 1: 2.4

Difficulty: Easy

136) Draw all isomers of  $C_3H_8O$  and classify each according to functional group.

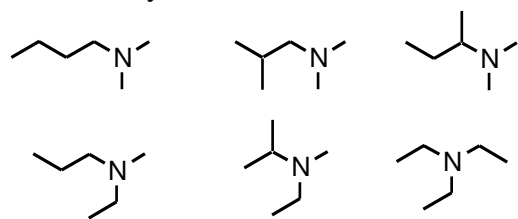


Topic: Isomers, Functional Groups

Section Reference 1: 1.3, 2.6, and 2.7

Difficulty: Easy

137) Draw all tertiary amine isomers of  $C_6H_{15}N$ .



Answer:

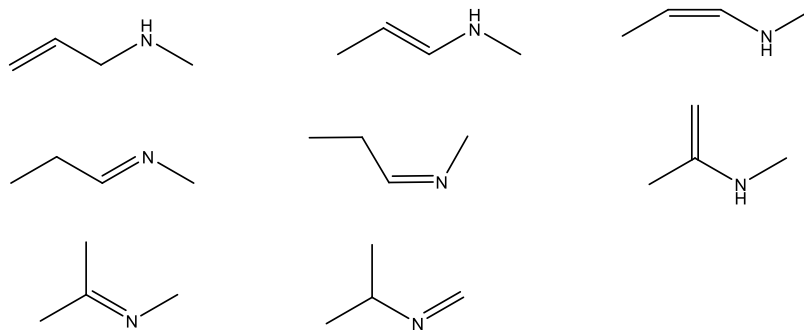
Topic: Isomers, Functional Groups

Section Reference 1: 1.3 and 2.8

Difficulty: Medium

138) Draw all of the acyclic secondary amines that have the chemical formula  $C_4H_9N$ .

Answer:



Topic: Isomers, Functional Groups

Section Reference 1: 1.3 and 2.8

Difficulty: Medium

139) A group in which a carbon atom has a double bond to an oxygen atom is called a \_\_\_\_.

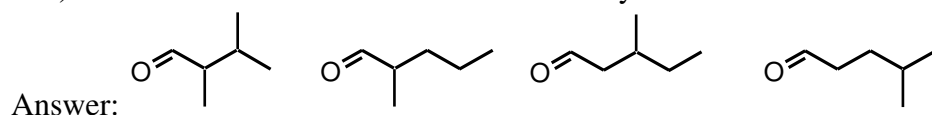
Answer: carbonyl

Topic: Functional Groups

Section Reference 1: 2.9

Difficulty: Easy

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

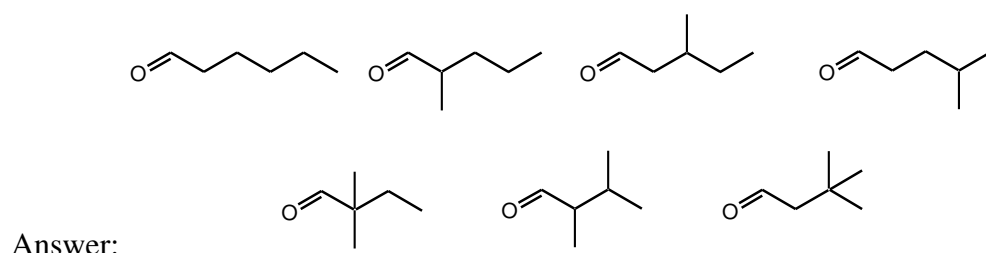


Topic: Isomers, Functional Groups

Section Reference 1: 2.9

Difficulty: Easy

141) Draw all isomers of  $C_6H_{12}O$  that are aldehydes.

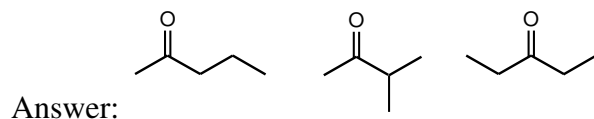


Topic: Isomers, Functional Groups

Section Reference 1: 1.3 and 2.9

Difficulty: Easy

142) Draw all isomers of  $C_5H_{10}O$  that are ketones.



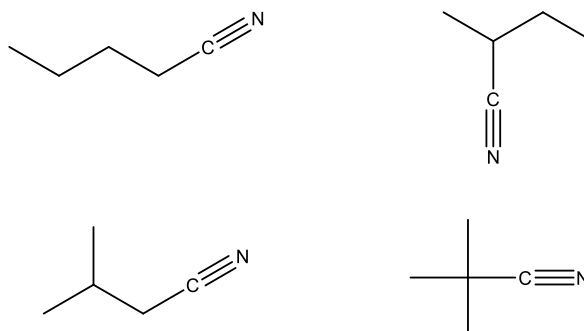
Topic: Isomers, Functional Groups

Section Reference 1: 1.3 and 2.9

Difficulty: Easy

143) Draw all of the isomers of  $C_5H_9N$  that are nitriles.

Answer:



Topic: Isomers, Functional Groups

Section Reference 1: 1.3, 2.11

Difficulty: Easy

Question type: Essay

144) 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.

Answer: 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 Reference 1: 2.13

Difficulty: Easy

145) Even though methanol ( $CH_3OH$ ) and methylamine ( $CH_3NH_2$ ) have similar molecular weights, methanol has a much higher boiling point of  $65^\circ C$  as opposed to methylamine's boiling point of  $-6^\circ C$ . Briefly explain why.

Answer: Both compounds have the same strong intermolecular forces of hydrogen bonding, but methanol's O-H bond is much more polarized than methylamine's N-H as oxygen is more electronegative than nitrogen. The greater polarization exposes the hydrogen nucleus further and creates stronger hydrogen bonds.

Topic: Intermolecular Forces

Section Reference 1: 2.13

Difficulty: Easy

146) Ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , and dimethyl ether,  $\text{CH}_3\text{OCH}_3$ , have the same molar mass, yet ethanol has a much higher boiling point. Briefly explain why.

Answer: 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: Intermolecular Forces

Section Reference 1: 2.13

Difficulty: Easy

147) Sodium chloride, which is quite soluble in water, is not very soluble in hexane. Why?

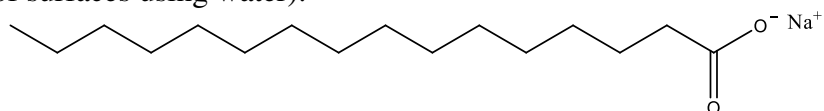
Answer: Sodium chloride, which is an ionic substance, is soluble in a polar solvent such as water, but not in a non-polar solvent such as hexane.

Topic: Bonding, Solubility

Section Reference 1: 2.13

Difficulty: Medium

148) Explain why the compound shown is considered to be capable of being a soap (dissolving oily substances off of surfaces using water).



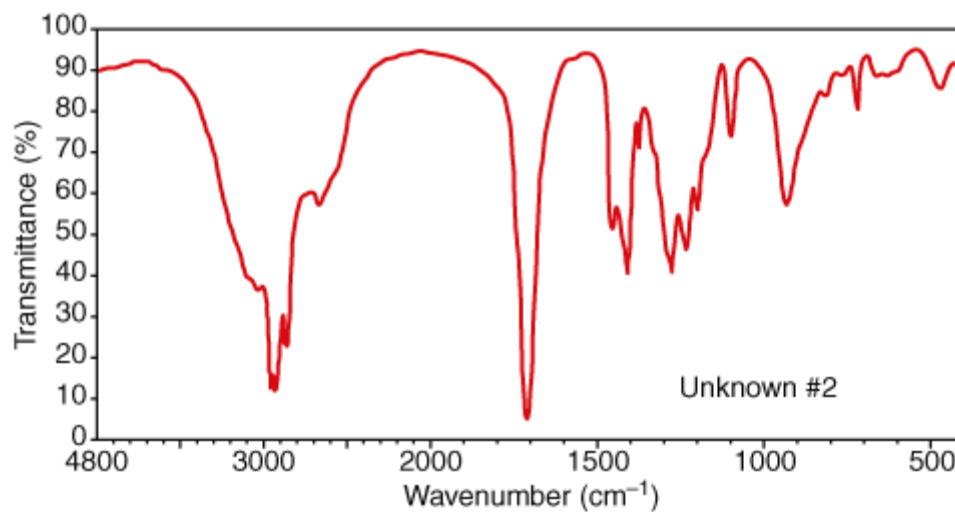
Answer: The compound contains a long hydrophobic “fatty” carbon tail, which attracts grease particles as they have similar dispersion forces. The polar hydrophilic carboxylate head is forced to the outside, which the polar water can now dissolve.

Topic: Bonding, Solubility

Section Reference 1: 2.13

Difficulty: Medium

149) Examine the following IR spectrum, for substance **Q** ( $\text{C}_7\text{H}_{14}\text{O}_2$ ). Which oxygen containing functional group is most likely present in **Q**?



(SDBS, National Institute of Advanced Industrial Science and Technology)

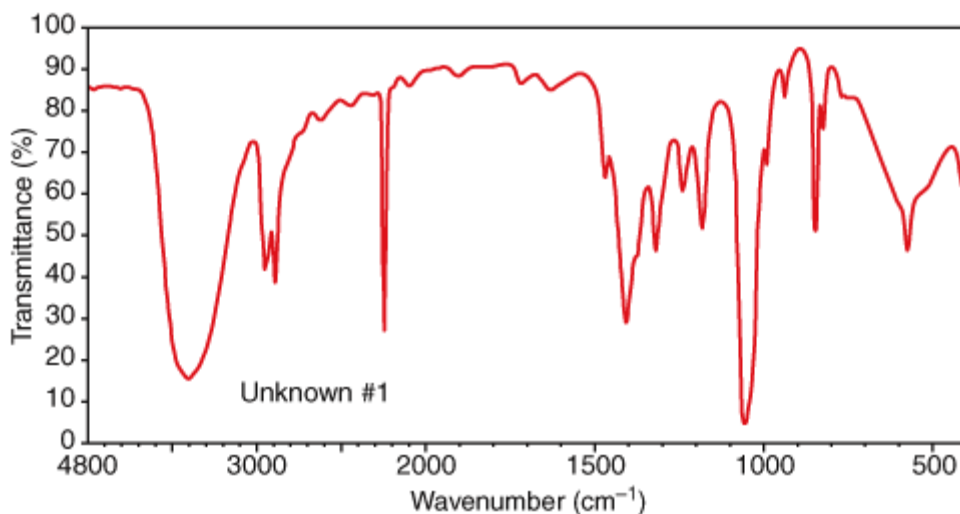
Answer: A carboxylic acid

Topic: Functional Groups, IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

150) Examine the following IR spectrum, for substance **P** ( $\text{C}_3\text{H}_5\text{NO}$ ). Which oxygen containing functional group is most likely present in **P**?



(SDBS, National Institute of Advanced Industrial Science and Technology)

Answer: Alcohol

Topic: Functional Groups, IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

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

Answer: 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 Reference 1: 2.15 and 2.16

Difficulty: Hard

152) IR absorption signals of alcohols are typically broad. However, IR spectra of gaseous samples show sharp peaks. Briefly explain why.

Answer: 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: IR Spectroscopy

Section Reference 1: 2.15 and 2.16

Difficulty: Medium

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

Answer: An alkene

Topic: Functional Groups, IR Spectroscopy

Section Reference 1: 2.1, 2.15, and 2.16

Difficulty: Easy

154) An IR spectrum has significant peaks at 2200 and 3300  $\text{cm}^{-1}$ . What functional group is present in the molecule?

Answer: A terminal alkyne

Topic: Functional Groups, IR Spectroscopy

Section Reference 1: 2.1, 2.15, and 2.16

Difficulty: Hard