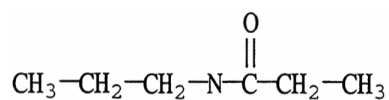


MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

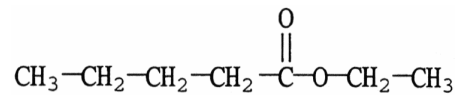
1) Which molecule is a carboxylic acid?

1) _____

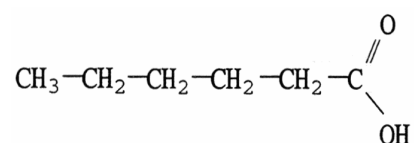
A)



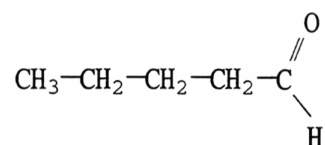
B)



C)



D)

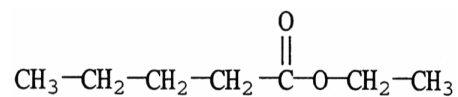


E) $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{NH}_2$

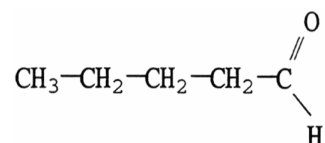
2) Which molecule is an ester?

2) _____

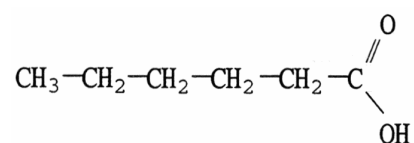
A)



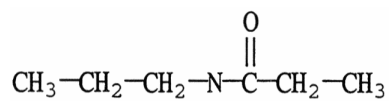
B)



C)



D)

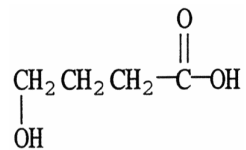


E) $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{NH}_2$

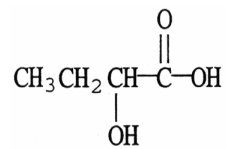
6) Which molecule shown is β -hydroxy butyric acid?

6) _____

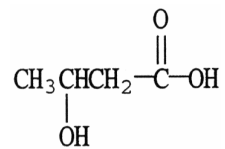
A)



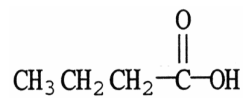
B)



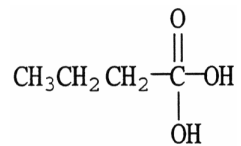
C)



D)



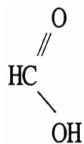
E)



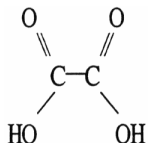
7) Which molecule is formic acid?

7) _____

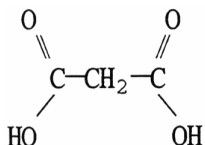
A)



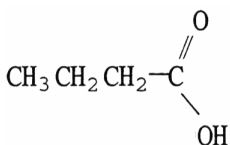
B)



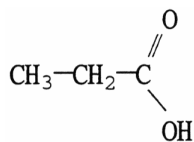
C)



D)



E)



8) All of the statements concerning citric acid are true **except**

8) _____

- A) It is produced only by plants.
- B) It contains three carboxylic acid groups because its carbon skeleton is branched.
- C) Its salts are used in many consumer products.
- D) It is a weak acid.
- E) It is very soluble in water.

9) Which of the following bonds is **not** present in a carboxylic acid functional group?

9) _____

- A) O-H
- B) C-O
- C) C=O
- D) C=C
- E) none of the above

10) Which compound is a carboxylic acid?

10) _____

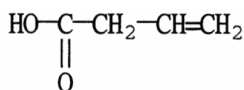
- A) CH_3COOH
- B) $(\text{CH}_3\text{CO})_2\text{O}$
- C) $(\text{CH}_3)_2\text{CHOOCH}_3$
- D) $\text{CH}_3\text{COO}^-\text{K}^+$
- E) $(\text{CH}_3)_2\text{O}$

11) All of the statements about carboxylic acids are true **except** 11) _____
A) At low molecular weights they are liquids with sharp stinging odors.
B) When they behave as acids, the -OH group is lost leaving the CO⁻ ion.
C) They react with bases to form salts which are often more soluble than the original acid.
D) They undergo substitution reactions involving the -OH group.
E) They form hydrogen bonds, causing their boiling points to be higher than expected on the basis of molecular weight.

12) Which acid would be expected to have the **lowest** boiling point? 12) _____
A) stearic, CH₃(CH₂)₁₆CO₂H
B) acetic, CH₃CO₂H
C) benzoic, C₆H₅CO₂H
D) oxalic, (CO₂H)₂
E) formic, HCO₂H

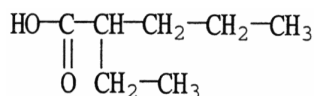
13) Which acid would be expected to have the **highest** boiling point? 13) _____
A) oxalic, (CO₂H)₂
B) benzoic, C₆H₅CO₂H
C) stearic, CH₃(CH₂)₁₆CO₂H
D) acetic, CH₃CO₂H
E) formic, HCO₂H

14) What is the IUPAC name of the compound shown? 14) _____



- A) 4-butanoic acid
- B) 1-butenic acid
- C) 3-butenic acid
- D) 1-butanoic acid
- E) none of the above

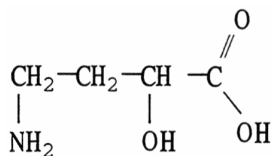
15) What is the IUPAC name of the compound shown? 15) _____



- A) 2-ethyl pentanoate
- B) 2-ethylpentanoic acid
- C) 3-hexanoic acid
- D) 4-heptanoic acid
- E) 3-heptanoic acid

16) What is the **common** name of the molecule shown?

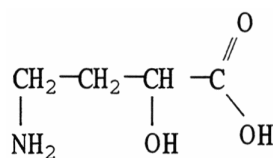
16) _____



- A) 4-amino-2-hydroxybutanoic acid
- B) α -amino- γ -hydroxybutyric acid
- C) γ -amino- α -hydroxybutyric acid
- D) 1-amino-3-hydroxybutanoic acid
- E) none of these

17) What is the **IUPAC** name of the molecule shown?

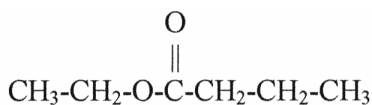
17) _____



- A) γ -amino- α -hydroxybutyric acid
- B) 4-amino-2-hydroxybutanoic acid
- C) 1-amino-3-hydroxybutanoic acid
- D) α -amino- γ -hydroxybutyric acid
- E) none of these

18) What is the **IUPAC** name of the molecule shown?

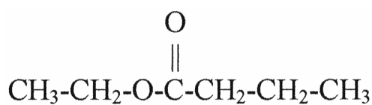
18) _____



- A) acetyl butyrate
- B) butyl acetate
- C) butyl ethanoate
- D) 2-hexanoic ester
- E) ethyl butanoate

19) What is the **common** name of the molecule shown?

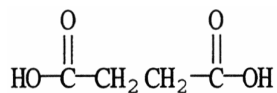
19) _____



- A) 2-hexanoic ester
- B) butyl ethanoate
- C) ethyl butanoate
- D) ethyl butyrate
- E) butyl acetate

20) What is the IUPAC name of the molecule shown?

20) _____



- A) ethanedioic
- B) diethanoic acid
- C) dibutanoic acid
- D) pentanedioic acid
- E) butanedioic acid

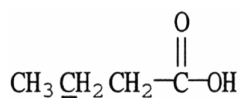
21) An acyl group is a group in which

21) _____

- A) a hydroxyl and an alkene are bonded to the same carbon atom.
- B) an amine and a carbonyl are bonded to the same carbon atom.
- C) an alpha carbon is bonded to an alkyl group.
- D) an acidic group is bonded to an aromatic group.
- E) an alkyl group is bonded to a carbonyl carbon atom.

22) When common names are used for acids, the underlined carbon atom in the molecule shown would be designated as the _____ C atom.

22) _____

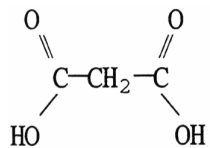


- A) gamma B) alpha C) #2 D) beta E) #1

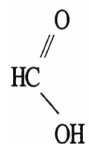
23) Which molecule is acetic acid?

23) _____

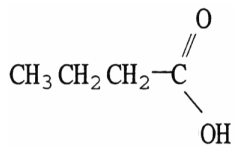
A)



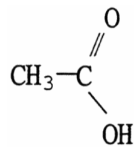
B)



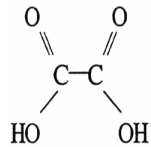
C)



D)



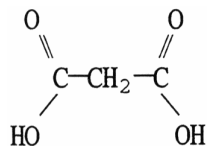
E)



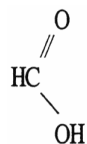
24) Which molecule is oxalic acid?

24) _____

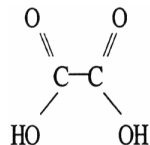
A)



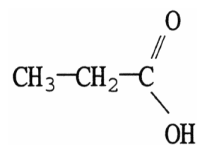
B)



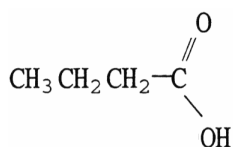
C)



D)

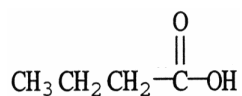


E)



25) What is the common name of the molecule shown?

25) _____



- A) formic acid
- B) oxalic acid
- C) lactic acid
- D) butyric acid
- E) acetic acid

26) Which acid would be expected to have the **lowest** boiling point?

26) _____

- A) benzoic
- B) formic
- C) stearic
- D) oxalic
- E) acetic

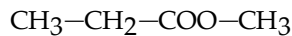
27) Which acid would be expected to have the **highest** boiling point?

27) _____

- A) stearic
- B) acetic
- C) formic
- D) oxalic
- E) benzoic

28) What is the IUPAC name of the compound shown?

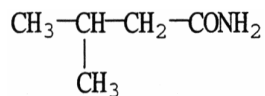
28) _____



- A) methyl propanoate
- B) methyl ethanoate
- C) propyl methanoate
- D) 3-butanoic acid
- E) 2-butanoic acid

29) What is the IUPAC name of the compound shown?

29) _____



- A) 2-methyl propanamide
- B) 3-methyl butanamide
- C) N-methyl propanamide
- D) N-methyl butanamide
- E) 2-methyl butanamide

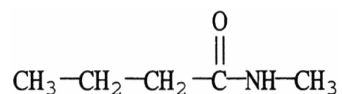
30) An alpha hydroxy carboxylic acid has an additional -OH group attached to the molecule at which location?

30) _____

- A) the carbon atom that contains the amine group
- B) the carbon atom farthest from the carboxyl group
- C) the #2 carbon atom
- D) the carbonyl carbon atom
- E) none of the above

31) What is the IUPAC name of the compound shown?

31) _____



- A) N-butylethanamide
- B) N-methylpropanamide
- C) N-butylformamide
- D) N-methylbutanamide
- E) 1-methylpropanamide

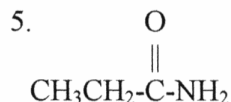
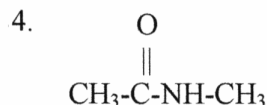
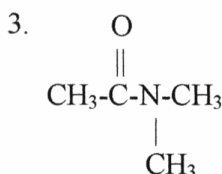
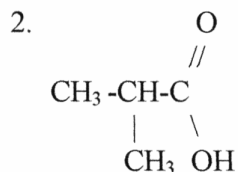
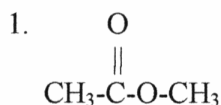
32) Carboxylic acids generally taste _____.

32) _____

- A) spicy
- B) sweet
- C) salty
- D) sour
- E) bitter

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 33) Which of the compounds shown can form hydrogen bonds with other identical molecules? 33) _____
Explain each case.

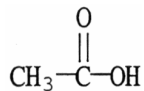


MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

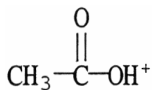
- 34) The solubility of compounds containing the carboxylic acid group can be increased by reaction with _____ 34) _____
A) nitric acid.
B) sodium hydroxide.
C) water.
D) sulfuric acid.
E) benzoic acid.
- 35) Which equation correctly represents the dissociation of a carboxylic acid in water? 35) _____
A) $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{CHCOOH}_2^+ + \text{OH}^-$
B) $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$
C) $\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+$
D) $\text{CH}_3\text{COOH} + 2 \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^{2-} + 2 \text{H}_3\text{O}^+$
E) $\text{CH}_3\text{COOH} + \text{H}_3\text{O}^+ \rightleftharpoons \text{CH}_3\text{COOH}_2^+ + \text{H}_2\text{O}$
- 36) The ion formed from a carboxylic acid is called the _____ 36) _____
A) amide cation.
B) carboxylate anion.
C) ester anion.
D) ester cation.
E) carboxylate cation.

37) Which formula correctly illustrates the form which acetic acid would take in a basic solution? 37) _____

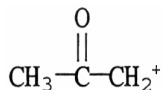
A)



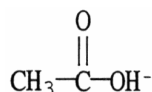
B)



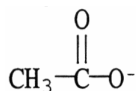
C)



D)



E)



38) Reaction of a carboxylic acid with a base like sodium hydroxide, NaOH gives _____ 38) _____

A) an alkoxide salt.

B) an ester.

C) an alcohol.

D) a carboxylate salt.

E) none of the above.

39) In the production of an ester, the carboxylic acid loses which atom or group of atoms? 39) _____

A) the entire $-\text{COOH}$ group

B) oxygen from the $-\text{OH}$

C) H from the $-\text{OH}$ group

D) the $-\text{OH}$ group

E) oxygen from the $-\text{C}=\text{O}$

40) When an alcohol reacts with a carboxylic acid the major product is _____ 40) _____

A) a soap.

B) an amine.

C) a salt.

D) an ester.

E) an amide.

41) Reaction of butanoic acid with ethanol produces _____ 41) _____

A) ethyl butanoate.

B) butyl ethyl ester.

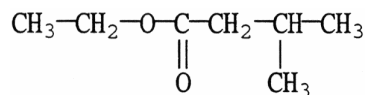
C) butyl ethanoate.

D) ethyl butanamide.

E) butyl ethanamide.

42) Which carboxylic acid is used to prepare the ester shown?

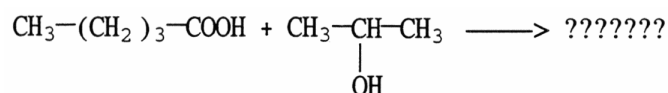
42) _____



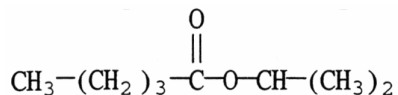
- A) $\text{CH}_3\text{---}(\text{CH}_2)_3\text{---COOH}$
- B) $\text{CH}_3\text{---CH}_2\text{---COOH}$
- C) $\text{CH}_3\text{---COOH}$
- D) $(\text{CH}_3)_2\text{---CH---COOH}$
- E) $(\text{CH}_3)_2\text{---CH---CH}_2\text{---COOH}$

43) What is the major organic product of the reaction shown?

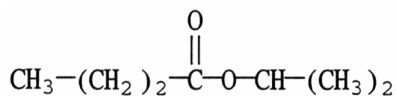
43) _____



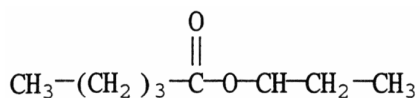
A)



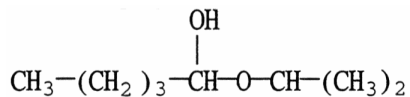
B)



C)



D)



E) $\text{CH}_3\text{---}(\text{CH}_2)_3\text{---O---CH}_2\text{---O---CH---}(\text{CH}_3)_2$

44) When an amine reacts with a carboxylic acid at high temperature the major product is

44) _____

- A) an ether.
- B) an ester.
- C) an alcohol.
- D) an amide.
- E) a thiol.

45) The common chemical name of aspirin is

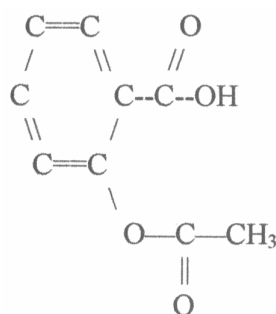
45) _____

- A) acetylsalicylic acid.
- B) phenylalanyl aspartic acid.
- C) acetamide.
- D) acetaminophen.
- E) lidocaine.

- 46) The reactants needed to produce simple polyamides (nylons) are 46) _____
- A) diacids and phosphates.
 - B) diacids and diamines
 - C) diacids and dialcohols.
 - D) alkenes and catalysts.
 - E) diamines and dialcohols.

- 47) The reactants needed to produce simple polyesters are 47) _____
- A) diacids and phosphates.
 - B) diacids and diamines
 - C) diacids and dialcohols.
 - D) diamines and dialcohols.
 - E) alkenes and catalysts.

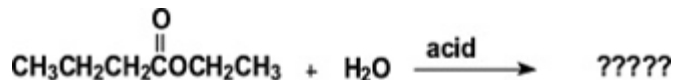
- 48) The functional groups in the aspirin molecule shown are 48) _____



- A) aromatic, carboxylic acid, ester
 - B) aromatic, ester
 - C) aromatic, carboxylic acid
 - D) carboxylic acid, ester
 - E) amide, aromatic, carboxylic acid
- 49) One requirement for the reactants in the formation of polyester is that each molecule contain 49) _____
- A) an amine group somewhere on the carbon skeleton.
 - B) one aromatic ring.
 - C) at least one carbon-carbon double bond.
 - D) at least two functional groups that can form ester linkages.
 - E) none of these
- 50) The products of acid hydrolysis of an ester are 50) _____
- A) another ester + water.
 - B) alcohol + acid.
 - C) acid + water.
 - D) salt + water.
 - E) alcohol + water.
- 51) The products of basic hydrolysis of an ester are 51) _____
- A) alcohol + water.
 - B) carboxylate salt + alcohol.
 - C) another ester + water.
 - D) alcohol + acid.
 - E) acid + water.

52) What are the major organic products of the reaction shown?

52) _____



- A) $\text{CH}_3\text{--CH}_2\text{--CH}_2\text{--CH}_2\text{OH} + \text{CH}_3\text{--CH}_2\text{OH}$
- B) $\text{CH}_3\text{--CH}_2\text{--CH}_2\text{--COO}^- + \text{H}_2\text{+O--CH}_2\text{--CH}_3$
- C) $\text{CH}_3\text{--CH}_2\text{--CH}_2\text{--COOH} + \text{HO--CH}_2\text{--CH}_3$
- D) $\text{CH}_3\text{--COOH} + \text{HO--CH}_2\text{--CH}_2\text{--CH}_2\text{--CH}_3$
- E) $\text{CH}_3\text{--CH}_2\text{--CH}_2\text{--COOH} + \text{CH}_3\text{--COOH}$

53) Reaction of an ester with a strong base is called

53) _____

- A) esterification.
- B) oxidation.
- C) saponification.
- D) condensation.
- E) reverse esterification.

54) Hydrolysis of the ester ethyl acetate produces _____

54) _____

- A) butanal and ethanol.
- B) butanol.
- C) butanoic acid.
- D) ethanol and acetic acid.
- E) ethanal and acetic acid.

55) The potassium or sodium salt of a long chain carboxylic acid is called a

55) _____

- A) emollient.
- B) soap.
- C) ester.
- D) triglyceride.
- E) none of the above

56) Hydrolysis of a carboxylic acid ester using base is called _____.

56) _____

- A) saponification
- B) detoxification
- C) extraction.
- D) alcoholysis
- E) decarboxylation

57) When an alcohol reacts with phosphoric acid, the product is referred to as a

57) _____

- A) phosphate anion.
- B) phosphate salt.
- C) phosphate ester.
- D) pyrophosphate.
- E) none of the above

- 58) Nylons and proteins are both referred to as polyamides because 58) _____
- A) each reactant molecule contains an amide group.
 - B) they are produced by basic hydrolysis of an amine.
 - C) they are formed when an acid functional group reacts with an amine functional group.
 - D) they are produced by reaction between an amide and an ester.
 - E) they are formed when an acid reacts with ammonia.

MATCHING. Choose the item in column 2 that best matches each item in column 1.

Match the following.

- | | | |
|-------------------------|--|-----------|
| 59) ethanoic acid | A) the type of ester produced when phosphoric acid reacts with three molecules of alcohol | 59) _____ |
| 60) amide group | | 60) _____ |
| 61) methanoic acid | B) The common name of this compound is acetic acid. | 61) _____ |
| 62) ester | C) a functional group formed when two acid molecules give up one water molecule | 62) _____ |
| 63) acid anhydride | | 63) _____ |
| 64) alpha carbon | D) the carbon atom bonded directly to the carbonyl carbon atom | 64) _____ |
| 65) nylon | E) a polymer produced by reacting diamines with diacids or diacyl chlorides | 65) _____ |
| 66) phosphate triester | | 66) _____ |
| 67) phosphate monoester | F) a functional group consisting of an amine group bonded to a carbonyl carbon | 67) _____ |
| 68) triphosphate | G) a molecule that contains one phosphate ester linkage and two phosphoric anhydride linkages | 68) _____ |
| | H) The common name of this compound is formic acid. | |
| | I) a functional group consisting of a carbonyl carbon with a single bond to another oxygen; the remaining bonds are formed with R groups | |
| | J) the type of ester produced when phosphoric acid reacts with one molecule of alcohol | |

69) diphosphate

A) a molecule that contains one phosphate ester linkage and one phosphoric anhydride linkage

69) _____

70) phosphorylation

B) the type of ester produced when phosphoric acid reacts with two molecules of alcohol

70) _____

71) phosphate diester

C) the transfer of a phosphoryl group from one molecule to another

71) _____

Answer Key

Testname: UNTITLED1

- 1) C
- 2) A
- 3) D
- 4) D
- 5) E
- 6) C
- 7) A
- 8) A
- 9) D
- 10) A
- 11) B
- 12) E
- 13) C
- 14) C
- 15) B
- 16) C
- 17) B
- 18) E
- 19) D
- 20) E
- 21) E
- 22) D
- 23) D
- 24) C
- 25) D
- 26) B
- 27) A
- 28) A
- 29) B
- 30) C
- 31) D
- 32) D

33) Molecules 2, 4, and 5 can form hydrogen bonds. In each case there is at least one hydrogen atom bonded to oxygen or nitrogen. This causes the hydrogen atom to become polarized resulting in $\delta+$ and $\delta-$ portions of each molecule so that hydrogen bonds can form. In the ester and the tertiary amide, #1 and #3, the functional groups are very polar, but there is no $\delta+$ charge.

- 34) B
- 35) B
- 36) B
- 37) E
- 38) D
- 39) D
- 40) D
- 41) A
- 42) E
- 43) A
- 44) D
- 45) A
- 46) B
- 47) C

Answer Key

Testname: UNTITLED1

- 48) A
- 49) D
- 50) B
- 51) B
- 52) C
- 53) C
- 54) D
- 55) B
- 56) A
- 57) C
- 58) C
- 59) B
- 60) F
- 61) H
- 62) I
- 63) C
- 64) D
- 65) E
- 66) A
- 67) J
- 68) G
- 69) A
- 70) C
- 71) B