The Carboxyl Group: Structure and Naming

What –COOH really is: a carbonyl and a hydroxyl on one sp² carbon, joined by resonance that makes the carbon less electrophilic than in aldehydes; and how carboxylic acids get their common and IUPAC names.

Name: Date: Score: ____ / 14

A. Fill in the blanks

1. The carboxyl group is a carbonyl group plus a ____ group.

2. The carboxyl carbon is ____ hybridised.

3. The IUPAC name of HCOOH is ____ acid.

4. HOOC–COOH is ethane____ acid.

B. True or False

5. The carboxyl carbon is more electrophilic than an aldehyde's carbonyl carbon. True / False

6. Acetic acid takes its name from vinegar. True / False

7. In naming acids, the COOH carbon is C-1. True / False

C. Assertion and reason

8. Assertion (A): Carboxylic acids do not give the nucleophilic addition reactions of aldehydes.
Reason (R): Resonance makes the carboxyl carbon less electrophilic.

(a) Both A and R are true, and R explains A
(b) Both A and R are true, but R does not explain A
(c) A is true, R is false
(d) A is false, R is true

Answer: _____

D. Choose the correct option

9. The IUPAC name of $(CH_3)_2CHCOOH$ is:

(a) butanoic acid
(b) 2-methylpropanoic acid
(c) 3-methylpropanoic acid
(d) isobutanoic acid

Answer: _____

10. Butyric acid is named after:

(a) ants
(b) vinegar
(c) butter
(d) wine

Answer: _____

11. Bond angles round the carboxyl carbon are about:

(a) 90°
(b) 109.5°
(c) 120°
(d) 180°

Answer: _____

E. Numerical problems

12. How many carbons are in the parent chain of 2-methylpropanoic acid?

F. Short answer questions

13. Show with curved arrows the resonance in the carboxyl group.

G. Match the columns

14. Match each item in Column A with the correct item in Column B.

Column A	Column B	Your answer
1. HCOOH	(a) ethanoic acid	1 → ____
2. CH_3COOH	(b) ethanedioic acid	2 → ____
3. HOOC–COOH	(c) benzoic acid	3 → ____
4. C_6H_5COOH	(d) methanoic acid	4 → ____

Detailed solutions

1. hydroxyl

2. sp^2

3. methanoic

4. dioic

5. False. Resonance with the –OH lone pair makes it less electrophilic.

6. True. Latin acetum = vinegar.

7. True. Numbering starts at the carboxyl carbon.

8. (a) R explains A.

9. (b) 2-methylpropanoic acid. Three-carbon chain from the COOH carbon, methyl on C-2.

10. (c) butter. Latin butyrum = butter.

11. (c) 120°. sp^2, planar.

12. propan-: three carbons. **Answer: 3**

13. R–C(=O)–OH ⟷ R–C(–O^-)=O^+–H: an –OH lone pair moves into the C–O bond; the C=O π pair moves onto O.

14. 1 → (d), 2 → (a), 3 → (b), 4 → (c). Each formula matches its IUPAC name.