Why Carboxylic Acids Are Acidic: Resonance and Substituents

Why vinegar fizzes with baking soda: the carboxylate ion shares its charge equally between two oxygens (resonance, arrow by arrow), which makes carboxylic acids stronger than phenols and alcohols; electron-withdrawing groups such as chlorine make them stronger still.

Name: Date: Score: ____ / 15

A. Fill in the blanks

1. Carboxylic acids liberate ____ gas from $NaHCO_3$.

2. The conjugate base of a carboxylic acid is the ____ ion.

3. A lower pKa means a ____ acid.

4. The effect by which Cl increases acidity is the ____ effect.

B. True or False

5. Phenol liberates CO_2 from $NaHCO_3$. True / False

6. Both C–O bonds of the acetate ion have the same length. True / False

7. Electron-donating groups increase the acidity of carboxylic acids. True / False

C. Assertion and reason

8. Assertion (A): Chloroacetic acid is stronger than acetic acid.
Reason (R): Cl withdraws electrons (–I) and stabilises the carboxylate.

(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: _____

9. Assertion (A): Ethanol does not react with $NaHCO_3$.
Reason (R): Ethoxide has no resonance stabilisation.

(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

10. Increasing acidity:

(a) ethanol < phenol < acetic acid
(b) acetic acid < phenol < ethanol
(c) phenol < ethanol < acetic acid
(d) ethanol < acetic acid < phenol

Answer: _____

11. pKa of trichloroacetic acid is about:

(a) 4.8
(b) 2.9
(c) 1.3
(d) 0.7

Answer: _____

12. In phenoxide, the negative charge is delocalised onto:

(a) two equal O atoms
(b) ring carbons
(c) the H atoms
(d) nowhere

Answer: _____

E. Numerical problems

13. How many equivalent resonance structures does the acetate ion have?

F. Short answer questions

14. Explain with curved arrows why acetic acid is a stronger acid than ethanol.

G. Match the columns

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

Column A	Column B	Your answer
1. CH_3COOH	(a) pKa 4.8	1 → ____
2. $ClCH_2COOH$	(b) pKa 2.9	2 → ____
3. $Cl_2CHCOOH$	(c) pKa 0.7	3 → ____
4. Cl_3CCOOH	(d) pKa 1.3	4 → ____

Detailed solutions

1. CO_2

2. carboxylate

3. stronger

4. –I (inductive)

5. False. Phenol is too weak an acid.

6. True. Two equivalent resonance structures.

7. False. They decrease it; electron-withdrawing groups increase it.

8. (a) R explains A.

9. (a) R explains A.

10. (a) ethanol < phenol < acetic acid. pKa ≈ 16, 10, 4.8.

11. (d) 0.7. Three Cl: strongest.

12. (b) ring carbons. Less electronegative carbons, so less stabilisation.

13. R–C(=O)–O^- and R–C(–O^-)=O. **Answer: 2**

14. In acetate, an O^- lone pair forms C=O while the C=O π pair moves onto the other O: two equivalent structures share the charge. Ethoxide has no resonance: the charge stays on one O. The more stable anion makes acetic acid stronger.

15. 1 → (a), 2 → (b), 3 → (d), 4 → (c). Each acid matches its pKa.