HVZ Reaction and Why Benzoic Acid Goes Meta

Two places a carboxylic acid can be substituted: the α-carbon (HVZ: X_2 and red phosphorus, then water) and the benzene ring of an aromatic acid, where –COOH is deactivating and meta-directing and blocks Friedel-Crafts reactions.

Name: Date: Score: ____ / 15

A. Fill in the blanks

1. In the HVZ reaction the halogen is used with a small amount of red ____.

2. CH_3COOH gives ____ acid in the HVZ reaction with Cl_2.

3. –COOH on a benzene ring is a ____-directing group.

4. Nitration of benzoic acid gives ____-nitrobenzoic acid.

B. True or False

5. HVZ replaces an α-hydrogen by a halogen. True / False

6. $(CH_3)_3CCOOH$ undergoes the HVZ reaction. True / False

7. Benzoic acid undergoes Friedel-Crafts acylation easily. True / False

C. Assertion and reason

8. Assertion (A): Benzoic acid is nitrated at the meta position.
Reason (R): –COOH withdraws electrons and leaves positive charge at ortho and para.

(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): Trimethylacetic acid does not give the HVZ reaction.
Reason (R): It has no α-hydrogen.

(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. The HVZ product from propanoic acid with Br_2 / red P, then water, is:

(a) 3-bromopropanoic acid
(b) 2-bromopropanoic acid
(c) bromoethane
(d) propanoyl bromide

Answer: _____

11. In benzoic acid, positive charge from resonance appears at:

(a) meta only
(b) ortho and para
(c) ipso only
(d) all ring carbons equally

Answer: _____

12. Bromination of benzoic acid ($Br_2/FeBr_3$) gives:

(a) o-bromobenzoic acid

(b) p-bromobenzoic acid

(c) m-bromobenzoic acid

(d) bromobenzene

Answer: _____

E. Numerical problems

13. How many α-hydrogens does acetic acid have?

F. Short answer questions

14. Give two reasons why benzoic acid does not undergo Friedel-Crafts reaction.

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. X_2 / red P, then H_2O	(a) m-nitrobenzoic acid	1 → ____
2. conc. HNO_3 + H_2SO_4 on benzoic acid	(b) α-halo acid	2 → ____
3. Br_2 / $FeBr_3$ on benzoic acid	(c) no reaction	3 → ____
4. RCOCl / $AlCl_3$ on benzoic acid	(d) m-bromobenzoic acid	4 → ____

Detailed solutions

1. phosphorus

2. chloroacetic

3. meta

4. m

5. True. The product is an α-halo acid.

6. False. It has no α-hydrogen.

7. False. The ring is deactivated and $AlCl_3$ bonds to –COOH.

8. (a) R explains A.

9. (a) R explains A.

10. (b) 2-bromopropanoic acid. The bromine goes to the α-carbon (C-2).

11. (b) ortho and para. So the electrophile goes meta.

12. (c) m-bromobenzoic acid. Meta substitution.

13. The CH_3 carbon is the α-carbon.. **Answer: 3**

14. The ring is deactivated by –COOH; the catalyst $AlCl_3$ (a Lewis acid) bonds to the carboxyl group.

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