Preparing Carboxylic Acids: Four Routes

Four ways to make a carboxylic acid: oxidising primary alcohols and aldehydes, oxidising alkylbenzenes, hydrolysing nitriles and esters, and adding a Grignard reagent to dry ice, which adds one carbon (mechanism with curved arrows).

Name: Date: Score: ____ / 14

A. Fill in the blanks

1. Primary alcohols are oxidised to carboxylic acids by acidified $K_2Cr_2O_7$ or ____.

2. Toluene on oxidation gives ____ acid.

3. Partial hydrolysis of a nitrile gives an ____.

4. RMgX + CO_2, then H_3O^+, gives an acid with ____ carbon more.

B. True or False

5. Oxidation of ethanol to ethanoic acid changes the number of carbons. True / False

6. Propylbenzene gives benzoic acid with hot $KMnO_4$. True / False

7. Esters give carboxylic acids on hydrolysis. True / False

C. Assertion and reason

8. Assertion (A): tert-Butylbenzene is not oxidised to benzoic acid by $KMnO_4$.
Reason (R): Its ring-attached carbon carries no H.

(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. CH_3CH_2MgBr + CO_2, then H_3O^+, gives:

(a) ethanoic acid
(b) propanoic acid
(c) butanoic acid
(d) ethanol

Answer: _____

10. Dry ice is solid:

(a) water
(b) CO_2
(c) nitrogen
(d) ammonia

Answer: _____

11. The species that attacks CO_2 in the Grignard route is:

(a) Br^-
(b) the C–Mg bond pair
(c) Mg^{2+}
(d) H_3O^+

Answer: _____

E. Numerical problems

12. How many carbons does the acid from CH_3Br via the Grignard route have?

F. Short answer questions

13. Convert bromobenzene into benzoic acid.

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. CH_3CH_2OH, $KMnO_4$	(a) CH_3COOH	1 → ____
2. toluene, $KMnO_4$	(b) benzoic acid	2 → ____
3. RCN, H_3O^+	(c) CH_3COOH	3 → ____
4. CH_3MgBr, CO_2 then H_3O^+	(d) RCOOH	4 → ____

Detailed solutions

1. $KMnO_4$

2. benzoic

3. amide

4. one

5. False. The carbon count stays the same.

6. True. The whole side chain becomes one COOH.

7. True. Acid hydrolysis gives the acid; basic hydrolysis gives its salt.

8. (a) R explains A.

9. (b) propanoic acid. Two carbons + one from CO_2 = propanoic acid.

10. (b) CO_2. Solid carbon dioxide.

11. (b) the C–Mg bond pair. The polar C–Mg bond, carbon δ^-.

12. CH_3COOH. **Answer: 2**

13. $C_6H_5Br + Mg$ (dry ether) $\rightarrow C_6H_5MgBr$; $+ CO_2 \rightarrow C_6H_5COO^- {}^+MgBr$; $+ H_3O^+ \rightarrow C_6H_5COOH$.

14. 1 → (c), 2 → (b), 3 → (d), 4 → (a). Each starting material and reagent gives that acid.