Unit 14 · Carboxylic Acids and Their Derivatives

WORKSHEET

Full marks 37

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 37

1 Key words [4]

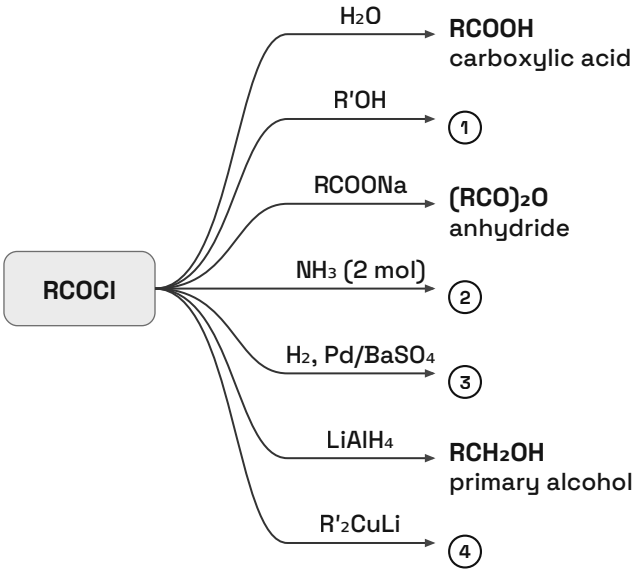
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

aldol	**carboxylate**	**Claisen**	**dimer**	**Hofmann**	**HVZ**	**nitrile**	**Rosenmund**	**soda lime**	**α-carbon**

A carboxylic acid's carboxyl carbon is C1, and the carbon next to it is the _____. In the liquid, two acid molecules join by two hydrogen bonds as a _____. The ion left when an acid gives up its proton, $RCOO^-$, is the _____ ion. A halogen is put on the α-carbon by red phosphorus and the halogen in the _____ reaction. Heating a sodium salt with _____ removes CO_2 and gives a hydrocarbon. An acid chloride is reduced to an aldehyde with H_2 over $Pd/BaSO_4$ in the _____ reduction. Two ester molecules join to a β-keto ester in the _____ condensation, and an amide loses a carbon in the _____ bromamide reaction.

2 Label the diagram [2]

The map shows how an acid chloride, RCOCl, is turned into other compounds. Write the product that belongs in place of 1 to 4. Each carries 0.5 mark.



1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. Which is the strongest acid? [1]

a. ethanoic acid
b. propanoic acid
c. chloroethanoic acid
d. trichloroethanoic acid

ii. Which reagent tells a carboxylic acid from a phenol, by giving a brisk effervescence only with the acid? [1]

a. NaOH solution
b. $NaHCO_3$ solution
c. sodium metal
d. neutral $FeCl_3$ solution

iii. Malonic acid, heated just above its melting point, gives: [1]

a. methanoic acid and CO_2
b. ethanoic acid and CO_2
c. its anhydride and water
d. propanoic acid

iv. Methanoic acid, unlike ethanoic acid, gives a silver mirror with Tollens' reagent because: [1]

a. it is a stronger acid
b. its molecule also has an aldehyde group, H–C=O
c. it has no α-hydrogen
d. it boils lower

v. The derivatives of carboxylic acids, from most to least reactive, are: [1]

a. acid chloride > anhydride > ester > amide
b. amide > ester > anhydride > acid chloride
c. ester > acid chloride > amide > anhydride
d. anhydride > acid chloride > amide > ester

4 Short answers [11]

Write short answers to the following questions.

a. Why does ethanoic acid (60 g/mol) boil at 118 °C, higher than propan-1-ol (60 g/mol, 97 °C)? [2]

b. Why is ethanoic acid an acid while ethanol is not (pK_a 4.76 against 15.9)? [2]

c. Write balanced equations for the reaction of ethanoic acid with i. PCl_5 and ii. thionyl chloride. Why is $SOCl_2$ often preferred? [2]

d. Write the equation for the HVZ reaction of propanoic acid with chlorine, and name the product. **[2]**

e. How do the Claisen and aldol condensations differ? Compare their conditions, reactants and products. **[3]**

5 Long answer **[4]**

Write a long answer to the following question.

Starting from ethanoic acid, how would you prepare i. ethanoyl chloride, ii. ethyl ethanoate, iii. ethanamide and iv. methane? Write an equation for each.

6 Numerical problems **[8]**

Solve the following problems. Show your working. Take H = 1, C = 12, O = 16, Na = 23, the molar volume of a gas at STP as 22.4 L, and pK_a of ethanoic acid 4.76.

a. A vinegar contains 5.0 g of ethanoic acid in every 100 mL. i. How many moles of ethanoic acid are in 20 mL of it? ii. What mass of baking soda, $NaHCO_3$, does it react with, and what volume of CO_2 (at STP) is given off? iii. Find the pH of a 0.10 M ethanoic acid solution, and the percentage of its molecules ionized. **[4]**

Answer:

b. 0.37 g of a saturated monocarboxylic acid, $C_nH_{2^n+1}COOH$, is exactly neutralized by 25.0 mL of 0.20 M NaOH. i. Find its molar mass. ii. Find n and name the acid. iii. Its sodium salt is heated with soda lime: name the gas and find its volume at STP. iv. Trichloroethanoic acid has pK_a 0.66: how many times stronger an acid is it than ethanoic acid? **[4]**

Answer: _____

7 Think **[3]**

2-Chlorobutanoic acid has pK_a 2.86, 3-chlorobutanoic acid 4.05 and 4-chlorobutanoic acid 4.52. What do these numbers show? Predict, with a reason, whether 2-fluorobutanoic acid would be stronger or weaker than 2-chlorobutanoic acid.

8 Activity: Vinegar and baking soda (not marked)

Put a spoonful of baking soda in a cup standing on a plate. Pour in a little vinegar, then more, a spoonful at a time, until it stops fizzing. Repeat with lemon juice and with a little dissolved aspirin.

Acid	What you see	Fizzing stops after (spoonfuls)
vinegar		
lemon juice		
aspirin		

Which gas makes the bubbles? How could you show it?