Follow the Bonds

Identify functional groups from the atoms they connect.

CHE.12.3 "Enrichment: Develop and use models to identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each of the seven functional group patterns in the passage, and circle the name that matches each pattern. Connect each pattern to its name with a pencil line.

What a Formula Reveals

1. At a fragrance lab, two clear liquids can smell different even when both contain carbon, hydrogen, and oxygen. Chemists look at how atoms connect, not just which atoms are present. A functional group is a recognizable arrangement of atoms that helps predict a molecule's behavior. In the shorthand below, R and R' stand for carbon-containing parts of a molecule; the parts need not be identical. A short line shows a single bond, while = shows a double bond. Follow each connection carefully: the same oxygen atom can signal different groups depending on its neighbors.

2. An alcohol has R-OH, with oxygen bonded to a carbon and a hydrogen. An ether has R-O-R', so its oxygen joins two carbon-containing parts. An amine can have R-NH_2, with nitrogen bonded to a carbon-containing part. The details matter: R-OH is not an ether, and R-NH_2 is not an alcohol. These patterns are pieces of larger structures, not complete molecular formulas. When reading a condensed formula, find the oxygen or nitrogen first. Then check the atoms directly attached to it before deciding which group you see. A single molecule may offer several places to inspect.

3. Another useful landmark is a carbonyl, a carbon double-bonded to oxygen, written C(=O). A ketone has R-C(=O)-R', with carbon-containing parts on both sides of that carbon. An aldehyde can have R-C(=O)-H, with hydrogen on one side. An organic acid, also called a carboxylic acid, can have R-C(=O)-OH. An ester has R-C(=O)-O-R'. Notice that an acid and an ester both contain a carbonyl next to an oxygen; the atom attached after that oxygen tells them apart. A molecule can contain more than one functional group, so inspect every part of its structure.

2 ANSWER WITH EVIDENCE

Use the passage

1. Identify the functional group in each formula: $CH_3CH_2CH_2OH$ and $CH_3CH_2OCH_3$. Which connection makes them different?

2. Identify the carbonyl-containing group in each formula: $CH_3C(=O)CH_2CH_3$ and $CH_3CH_2CH_2C(=O)H$. What is attached to each carbonyl carbon?

3. Identify the functional group in each formula: $CH_3C(=O)OH$ and $CH_3C(=O)OCH_3$. Which atom or group follows the oxygen next to the carbonyl?

4. Identify the functional group in each formula: $CH_3CH(NH_2)CH_3$ and $CH_3CH(OH)CH_3$. Which atoms helped you decide?

3 YOUR TURN

Your own words

Draw two different molecules as condensed structural formulas: one containing an ester and one containing an amine. Circle each functional group and label it; choose molecules not shown elsewhere on this page.

ANSWER KEY

Follow the Bonds

PART 1 · READ AND MARK

Underline each of the seven functional group patterns in the passage, and circle the name that matches each pattern. Connect each pattern to its name with a pencil line. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Identify the functional group in each formula: $CH_3CH_2CH_2OH$ and $CH_3CH_2OCH_3$. Which connection makes them different?	**The first is an alcohol: its oxygen is bonded to hydrogen. The second is an ether: its oxygen joins two carbon-containing parts.**
2	Identify the carbonyl-containing group in each formula: $CH_3C(=O)CH_2CH_3$ and $CH_3CH_2CH_2C(=O)H$. What is attached to each carbonyl carbon?	**The first is a ketone, with carbon-containing parts on both sides of the carbonyl carbon. The second is an aldehyde, with hydrogen on one side.**
3	Identify the functional group in each formula: $CH_3C(=O)OH$ and $CH_3C(=O)OCH_3$. Which atom or group follows the oxygen next to the carbonyl?	**The first is an organic acid; hydrogen follows that oxygen. The second is an ester; a carbon-containing part follows that oxygen.**
4	Identify the functional group in each formula: $CH_3CH(NH_2)CH_3$ and $CH_3CH(OH)CH_3$. Which atoms helped you decide?	**The first is an amine, identified by NH_2 bonded to carbon. The second is an alcohol, identified by OH bonded to carbon.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Ester: $CH_3CH_2C(=O)OCH_3$, with C(=O)O circled. Amine: $CH_3CH_2CH_2NH_2$, with NH_2 circled.

Accept other valid condensed formulas if one contains C(=O)O bonded to another carbon-containing part and the other contains an amine. The student must circle and correctly label both groups.