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23 FUNCTIONAL GROUPS

SECTION 23.1 INTRODUCTION TO FUNCTIONAL GROUPS (pages 725–729)

This section defines a functional group and gives several examples. It also describes halocarbons and the substitution reactions they undergo.

▶ Functional Groups (pages 725–726)

1. Is the following sentence true or false? The saturated hydrocarbon skeletons of organic molecules are chemically reactive. _____

2. What is a functional group? _____

_____

Use Table 23.1 on page 726 to answer Questions 3 and 4.

3. Name the functional group for each compound structure.

a. R — O — R _____ **b.** R — OH _____ **c.** R — NH_2 _____

4. Name two compound types that have a carbonyl group as a functional group.

a. _____ **b.** _____

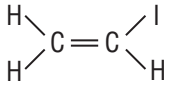
▶ Halogen Substituents (pages 726–728)

5. What are halocarbons? _____

_____

6. Give the IUPAC and common names for the following halocarbons.

a. $CH_3 — CH_2 — CH_2 — Br$ _____

b.  _____

7. A halogen attached to a carbon of an aliphatic chain produces a halocarbon called a(n) _____ .

Match the prefix used in naming alkyl groups with its description.

a. *iso-* **b.** *sec-* **c.** *tert-*

_____ **8.** The carbon joining this alkyl group to another group is bonded to three other carbons.

_____ **9.** The carbon joining this alkyl group to another group is bonded to two other carbons.

_____ **10.** The carbon joining this alkyl group to another group is bonded to one other carbon.

11. What is an aryl halide? _____

_____

▶ Substitution Reactions (pages 728–729)

12. Why do reactions involving organic compounds often proceed more slowly than those involving inorganic molecules and ions?

_____

13. Is the following sentence true or false? The products of organic reactions are often a complex mixture of compounds. _____

14. Organic reactions that involve the replacement of one atom or group of atoms with another atom or group of atoms are called _____ reactions.

15. Label the compounds in this generalized equation. (*X* stands for a halogen.)

_____ _____ _____ _____

16. Hydroxide ions can displace most halogens on carbon chains to produce a(n) _____ .

SECTION 23.2 ALCOHOLS AND ETHERS (pages 730–736)

This section describes the structures and naming of alcohols and ethers, as well as comparing their properties. It also defines and gives examples of addition reactions.

▶ Alcohols (pages 730–731)

1. What are alcohols?

_____

2. The functional group in an alcohol is called a(n) _____ group.

Match each structural category of aliphatic alcohols with its description.

_____ **3.** primary alcohol — **a.** three R groups attached to C — OH

_____ **4.** secondary alcohol — **b.** one R group attached to C — OH

_____ **5.** tertiary alcohol — **c.** two R groups attached to C — OH

6. Circle the letter of the IUPAC ending used for an alcohol with two — OH substitutions.

a. *-ol* **b.** *-tetrol* **c.** *-triol* **d.** *-diol*

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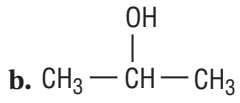
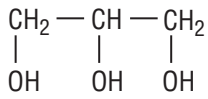
7. _____ is the common name for alcohols with more than one —OH substituent.

8. Write the IUPAC name and the common name for each alcohol shown.

a. $CH_3—CH_2—OH$ _____

b.  _____

c.  _____

▶ Properties of Alcohols (pages 732–733)

9. Is the following sentence true or false? Alcohols cannot form intermolecular hydrogen bonds. _____

10. What are the two parts of an alcohol molecule?

_____

11. Why are alcohols with four or more carbons not soluble in water?

_____

_____

12. Name two uses for isopropyl alcohol.

a. _____

b. _____

13. Which alcohol is used in many antifreezes? _____

14. The action of yeast or bacteria on sugars to produce ethanol is called _____ .

15. How is ethanol denatured?

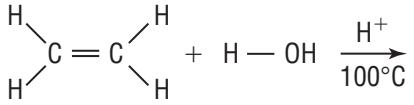
_____

▶ Addition Reactions (pages 733–735)

16. Adding new functional groups at the double or triple bond of an alkene or alkyne is called a(n) _____ reaction.

17. Is the following sentence true or false? Adding a hydrogen halide to an alkene results in a disubstituted halocarbon. _____

18. Look at the reaction between ethene and water:



a. Draw the structure of the product.

_____

b. What type of compound is the product? _____

c. What is this type of addition reaction called? _____

d. What is the role of the hydrogen ions? _____

19. What type of reaction is used to manufacture margarine from unsaturated vegetable oils? _____

20. Which hydrocarbon resists addition reactions? _____

▶ Ethers (pages 735–736)

21. An ether is a compound in which _____ is bonded to two carbon groups.

22. How are ethers named? _____

_____

23. Circle the letter of each symmetrical ether.

a. ethylmethyl ether

b. diethyl ether

c. diphenyl ether

d. methylphenyl ether

24. Is the following sentence true or false? Ethers have higher boiling points than alcohols of comparable molar mass. _____

Reading Skill Practice

By looking carefully at photographs and diagrams in your textbook, you can better understand what you have read. Look carefully at Figure 23.8 on page 734. What important idea do these photographs communicate? Do your work on a separate sheet of paper.

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SECTION 23.3 CARBONYL COMPOUNDS (pages 737–746)

This section explains how to distinguish among the carbonyl groups of aldehydes, ketones, carboxylic acids, and esters. It also describes the reactions of compounds that contain the carbonyl group.

▶ Aldehydes and Ketones (pages 737–740)

1. A _____ consists of a carbon joined by a double bond to an oxygen atom.

2. What is the difference between an aldehyde and a ketone? _____

_____

_____

3. What ending is used in the IUPAC system to indicate an aldehyde? a ketone?

_____

4. Circle the letter of each statement that is true about aldehydes and ketones.

a. In an aldehyde or ketone sample, the molecules cannot form intermolecular hydrogen bonds.

b. The molecules in an aldehyde or ketone sample do not attract each other through polar–polar interactions.

c. Most aldehydes and ketones are gases at room temperature.

d. Aldehydes and ketones can form weak hydrogen bonds with water.

Match the aldehyde or ketone with its use.

_____ **5.** methanal	**a.** almond flavoring
_____ **6.** propanone	**b.** preservative
_____ **7.** benzaldehyde	**c.** oil of cinnamon
_____ **8.** 3-phenyl-2-propenal	**d.** solvent

9. Aromatic aldehydes are often used as _____ agents.

▶ Carboxylic Acids (pages 740–741)

10. What is a carboxyl group?

_____

11. Is the following sentence true or false? Carboxylic acids are weak acids. _____

12. What ending is used under the IUPAC system to designate a carboxylic acid?

_____

13. Carboxylic acids with three or more carbons in a straight chain are also known as _____ acids.

14. Complete the table about saturated aliphatic carboxylic acids.

IUPAC Name	Common Name	Carbon Atoms	Formula
		4	$CH_3(CH_2)_2COOH$
Octanoic acid			$CH_3(CH_2)_6COOH$
	Acetic acid	2	
Octadecanoic acid	Stearic acid		

15. What form do all aromatic carboxylic acids have at room temperature?

_____

▶ Esters (pages 742–743)

16. An ester is a derivative of a _____ that has an —OR substituted for the —OH.

17. Write the general formula for an ester. _____

18. What two products are formed when an ester is hydrolyzed in the presence of a strong acid or base?

_____

▶ Oxidation–Reduction Reactions (pages 743–745)

19. Are triple carbon–carbon bonds more or less oxidized than double and single carbon–carbon bonds? _____

20. What is a dehydrogenation reaction? _____

_____

21. Circle the letter of the compound that is the final product of methane oxidation.

a. methanol **c.** methanal

b. formic acid **d.** carbon dioxide

22. Primary alcohols are oxidized to form _____, but secondary alcohols form _____ when oxidized.

23. Why are tertiary alcohols resistant to oxidation? _____

_____

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24. Is the following sentence true or false? The oxidation of organic compounds is exothermic. _____

25. What property of aldehydes do Fehling's test and Benedict's test take advantage of? What color is the precipitate that forms?

_____

SECTION 23.4 POLYMERIZATION (pages 747–752)

This section defines polymers and monomers. It also names and describes the uses of some important addition and condensation polymers.

▶ Addition Polymers (pages 747–749)

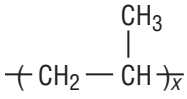
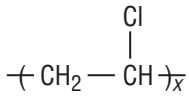
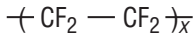
1. What are polymers? _____

_____

2. Is the following sentence true or false? Polymers can only contain one type of monomer. _____

3. Most polymerization reactions require a _____ .

4. Complete the table by naming each polymer.

Polymer	Structure
	
	
	
	

Match the polymer with its use.

_____ **5.** polyethylene
_____ **6.** polystyrene
_____ **7.** polytetrafluoroethene
_____ **8.** polyisoprene
_____ **9.** polyvinyl chloride

a. foam coffee cups
b. rubber tubing
c. nonstick cookware
d. plastic wrap
e. plumbing pipes

CHAPTER 23, Functional Groups *(continued)*

▶ Condensation Polymers (pages 750–752)

10. How is a polyester formed? _____

_____

11. For condensation polymerization to occur, each monomer molecule must have _____ functional groups.

12. Name the two monomer molecules that are joined to form the polyester PET.

_____

13. Garments made from PET fibers are _____ resistant.

14. Is the following sentence true or false? The polymer produced by the condensation of a carboxylic acid and an amine is called an amide. _____

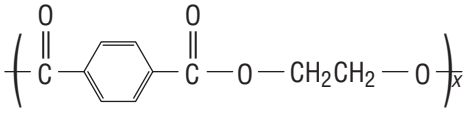
15. What common group of synthetic materials is made up by polyamides?

_____

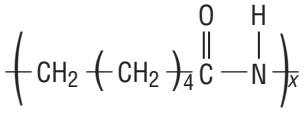
16. _____ are an important group of naturally occurring polyamides made from monomers called _____ .

Match each common polymer to its structural representation.

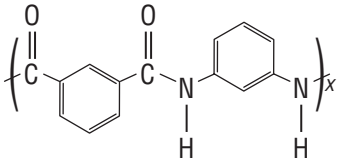
_____ **17.**



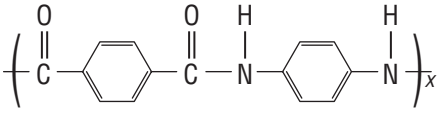
_____ **18.**



_____ **19.**



_____ **20.**



a. Kevlar
b. Nomex
c. nylon
d. PET