21.2 Nomenclature

Both IUPAC and common names are used for aldehydes and ketones.

21.2A Naming Aldehydes in the IUPAC System

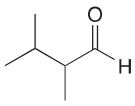
In IUPAC nomenclature, aldehydes are identified by a suffix added to the parent name of the longest chain. Two different suffixes are used, depending on whether the CHO group is bonded to a chain or a ring.

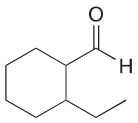
To name an aldehyde using the IUPAC system:

[1] If the CHO is bonded to a chain of carbons, find the longest chain containing the CHO group, and change the ***-e*** ending of the parent alkane to the suffix ***-al.*** If the CHO group is bonded to a ring, name the ring and add the suffix ***-carbaldehyde.***

[2] Number the chain or ring to put the CHO group at C1, but omit this number from the name. Apply all of the other usual rules of nomenclature.

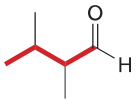
Sample Problem 21.1 Give the IUPAC name for each compound.

a. 

b. 

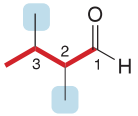
Solution

a. [1] Find and name the longest chain containing the CHO:



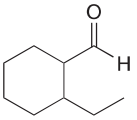
butane ⟶ butan*al*
(4 C's)

[2] Number and name substituents:



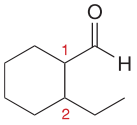
Answer: 2,3-dimethylbutanal

b. [1] Find and name the ring bonded to the CHO group:



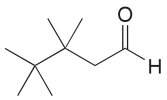
cyclohexane + carbaldehyde
(6 C's)

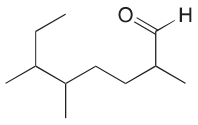
[2] Number and name substituents:

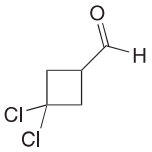


Answer:
2-ethylcyclohexanecarbaldehyde

Problem 21.3 Give the IUPAC name for each aldehyde.

a. 

b. 

c. 

Problem 21.4 Give the structure corresponding to each IUPAC name.

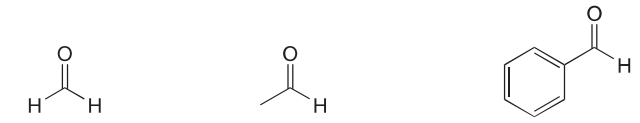
a. 2-isobutyl-3-isopropylhexanal
b. *trans*-3-methylcyclopentanecarbaldehyde
c. 1-methylcyclopropanecarbaldehyde
d. 3,6-diethylnonanal

21.2B Common Names for Aldehydes

Like carboxylic acids, many simple aldehydes have common names that are widely used.

- A common name for an aldehyde is formed by taking the common parent name and adding the suffix *-aldehyde.*

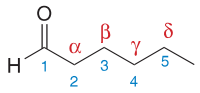
The common parent names are similar to those used for carboxylic acids, listed in Table 19.1. The common names **formaldehyde, acetaldehyde,** and **benzaldehyde** are virtually always used instead of their IUPAC names.



formaldehyde (methanal) | acetaldehyde (ethanal) | benzaldehyde (benzenecarbaldehyde)

(IUPAC names are in parentheses.)

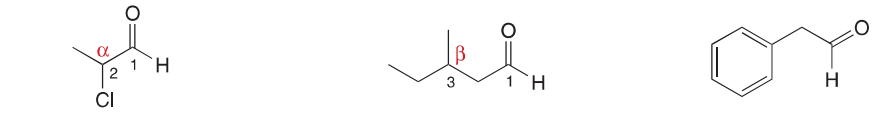
Greek letters are used to designate the location of substituents in common names. **The carbon adjacent to the CHO group is the α carbon,** and so forth down the chain.



IUPAC numbering begins at the C=O.
Greek lettering begins at the C bonded to the C=O.

Figure 21.1 gives the common and IUPAC names for three aldehydes.

Figure 21.1
Three examples of aldehyde nomenclature



2-chloropropanal (α-chloropropionaldehyde) | 3-methylpentanal (β-methylvaleraldehyde) | phenylethanal (phenylacetaldehyde)

(Common names are in parentheses.)

21.2C Naming Ketones in the IUPAC System

- In the IUPAC system all ketones are identified by the suffix *-one.*

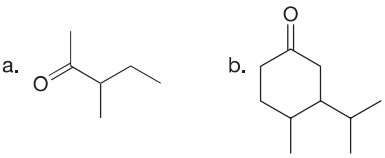
To name an acyclic ketone using IUPAC rules:

[1] Find the longest chain containing the carbonyl group, and change the ***-e*** ending of the parent alkane to the suffix ***-one.***

[2] Number the carbon chain to give the carbonyl carbon the lower number. Apply all of the other usual rules of nomenclature.

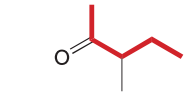
With cyclic ketones, numbering always begins at the carbonyl carbon, but the "1" is usually omitted from the name. The ring is then numbered clockwise or counterclockwise to give the first substituent the lower number.

Sample Problem 21.2 Give the IUPAC name for each ketone.



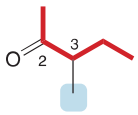
Solution

a. [1] Find and name the longest chain containing the carbonyl group:



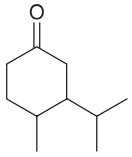
pentane → pentan*one*
(5 C's)

[2] Number and name substituents:



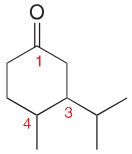
Answer: 3-methylpentan-2-one

b. [1] Name the ring:



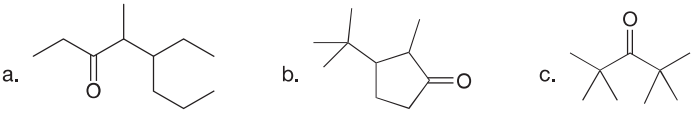
cyclohexane → cyclohexan*one*
(6 C's)

[2] Number and name substituents:



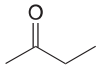
Answer:
3-isopropyl-4-methylcyclohexanone

Problem 21.5 Give the IUPAC name for each ketone.

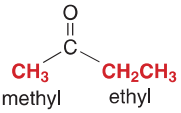


21.2D Common Names for Ketones

Most common names for ketones are formed by **naming both alkyl groups** on the carbonyl carbon, **arranging them alphabetically,** and adding the word ***ketone.*** Using this method, the common name for butan-2-one becomes ethyl methyl ketone.



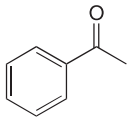
IUPAC name: **butan-2-one**



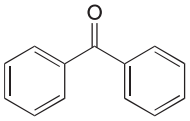
Common name: **ethyl methyl ketone**

Three widely used common names for some simple ketones do not follow this convention:

acetone



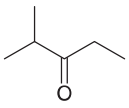
acetophenone



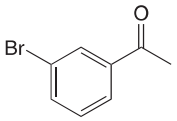
benzophenone

Figure 21.2 gives acceptable names for two ketones.

Figure 21.2
Two examples of ketone nomenclature



IUPAC name: 2-methylpentan-3-one
Common name: ethyl isopropyl ketone

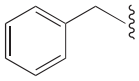


m-bromoacetophenone
or
3-bromoacetophenone

21.2E Additional Nomenclature Facts

Do not confuse a **benzyl** group with a **benzoyl** group.

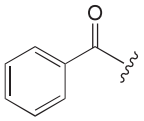
Sometimes acyl groups (RCO−) must be named as substituents. To name an acyl group, take either the IUPAC or common parent name and add the suffix ***-yl*** or ***-oyl.*** The three most common acyl groups are drawn below.



benzyl group

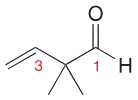
formyl group

acetyl group

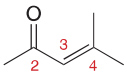


benzoyl group

Compounds containing both a C−C double bond and an aldehyde are named as **enals,** and compounds that contain both a C−C double bond and a ketone are named as **enones.** The chain is numbered to give the carbonyl group the lower number.



2,2-dimethylbut-3-enal

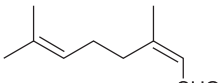


4-methylpent-3-en-2-one

Problem 21.6 Give the structure corresponding to each name: (a) *sec*-butyl ethyl ketone; (b) methyl vinyl ketone; (c) *p*-ethylacetophenone; (d) 3-benzoyl-2-benzylcyclopentanone; (e) 6,6-dimethylcyclohex-2-enone; (f) 3-ethylhex-5-enal.

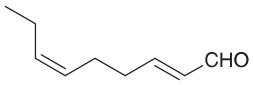
Problem 21.7 Give the IUPAC name (including any *E,Z* designation) for each unsaturated aldehyde. Neral is obtained from lemon grass, and cucumber aldehyde (Problem 1.30) contributes to the aroma of a fresh mango.

a.



neral

b.



cucumber aldehyde

21.3 Physical Properties

Aldehydes and ketones exhibit dipole–dipole interactions because of their polar carbonyl group. Because they have no O−H bond, two molecules of RCHO or RCOR are incapable of intermolecular hydrogen bonding, making them less polar than alcohols and carboxylic acids. How these intermolecular forces affect the physical properties of aldehydes and ketones is summarized in Table 21.1.

Problem 21.8 The boiling point of butan-2-one (80 °C) is significantly higher than the boiling point of diethyl ether (35 °C), even though both compounds exhibit dipole–dipole interactions and have comparable molecular weights. Offer an explanation.