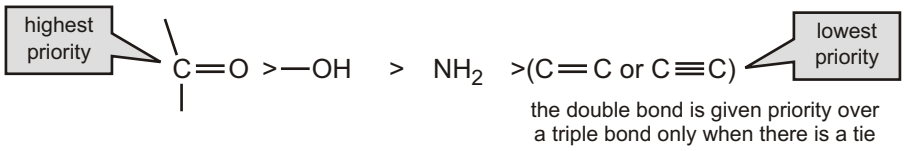
CHAPTER

9

Nomenclature of Alcohol, Ether, Aldehyde and Ketone

PRIORITIES OF FUNCTIONAL GROUP SUFFIXES



The following rules are used to name a compound that has a functional group suffix :

1. The parent hydrocarbon is the longest continuous chain containing the functional group .
2. The parent hydrocarbon is numbered in the direction that gives the functional group suffix the lowest possible number .

☑ SPECIAL TOPIC

NAME ALCOHOL COMES FROM ?

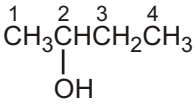
Arabic alchemy has given us a number of chemical terms; for example, alcohol is believed to derive from Arabic al-khwl or al-ghawl whose original meaning was a metallic powder used to darken women's eyelids (Kohl).

Alcohol entered the English language in the 17th Century with the meaning of a "sublimated" substance, then became the "pure spirit" of anything, and only became associated with "spirit of wine" in 1753. finally, in 1852, it become a part of chemical nomenclature that denoted a common class of organic compound. But it's still common practice to refer to the specific substance CH_3CH_2OH as "Alcohol" rather then its systematic name ethanol.

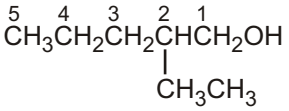
Solved Example

- $CH_3CH(OH)CH_3$
  - Functional groups is an alcohol, therefore suffix = -ol
  - Hydrocarbon structure is an alkane therefore -ane
  - The longest continuous chain is C3 therefore root = prop
  - It doesn't matter which end we number from, the alcohol group locant is 2-

Ans. Propan-2-ol

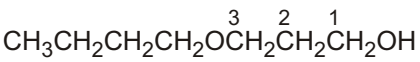


2-butanol
or
butan-2-ol



2-ethyl-1-pentanol
or
2-ethylpentan-1-ol

The longest continuous chain has six carbons, but the longest continuous chain containing the OH functional group has five carbons so the compound is named as a pentanol.

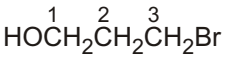


3-butoxy-1-propanol
or
3-butoxypropan-1-ol

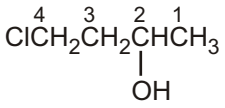
The longest continuous chain has four carbons, but the longest continuous chain containing the OH functional group has three carbons, so the compound is named as a propanol.

☞ If there is a functional group suffix and a substituent, the functional group suffix gets the lowest possible number.

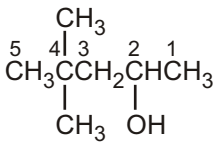
Solved Example



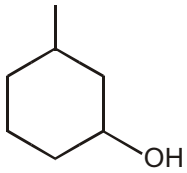
3-bromo-1-propanol



4-chloro-2-butanol



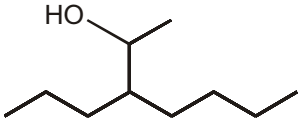
4,4-dimethyl-2-pentanol



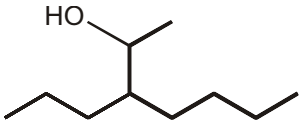
3-methylcyclohexanol
not
5-methylcyclohexanol

Solved Example

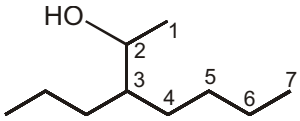
- For the compound below, choose the parent chain and then number it correctly :



Ans. To choose the parent chain, remember that we need to choose the longest chain containing the functional group:

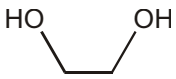


To number it correctly, we need to go in the direction that gives the functional group the lowest number:



NAME: 3-Propyl-2-heptanol

DIOLS (OR POLYOLS)

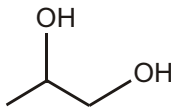


- Functional group is an alcohol, therefore suffix **= -ol**
- Hydrocarbon structure is an alkane therefore**-ane**
- There are two alcohols, so insert the multiplier **di**
- The longest continuous chain is C2 therefore root **= eth**

ethane-1,2-diol

or

1,2-ethanediol

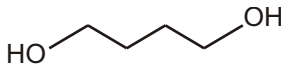


- Hydrocarbon structure is an alkane therefore**-ane**
- There are two alcohols, so insert the multiplier **di**
- The longest continuous chain is C3 therefore root **= prop**
- Locants for -OH units are **1-** and **2-**

Propane-1, 2-diol

or

1,2-propanediol

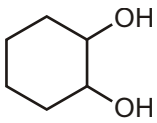


- Hydrocarbon structure is an alkane therefore **-ane**
- There are two alcohols, so insert the multiplier **di**
- The longest continuous chain is C4 therefore root **= but**

butane-1,4-diol

or

1,4-butanediol



- Hydrocarbon structure is an alkane therefore **-ane**
- There are two alcohols, so insert the multiplier **di**
- The ring is C6 therefore root **= cyclohex**
- Locants for –OH units are **1-** and **2-**

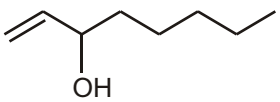
Cyclohexane-1,2-diol

or

1,2-cyclohexanediol

☑ SPECIAL TOPIC

HOW A BANANA SLUG KNOWS WHAT TO EAT



1-octene-3-ol

Many species of mushrooms synthesize 1-octen-3-ol, a repellent that drives off predatory slugs. Such mushrooms can be recognized by small bite marks on their caps, where the slug started to nibble before the volatile compound was released. People are not put off by the release of this compound because to them it just smells like a mushroom. 1-Octen-3-ol also has antibacterial properties that may protect the mushroom from organisms that would otherwise invade the wound made by the slug. Not surprisingly, the species of mushroom that banana slugs commonly eat cannot synthesize 1-octen-3-ol.

Solved Example

(a) $CH_3—CH_2—CH_2—CH_2—OH$
Butan-1-ol

(b) $CH_3—\underset{\displaystyle OH}{\underset{|}{CH}}—CH_3$
Propan-2-ol

(c) $CH_3—\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}—OH$
2-Methylpropan-2-ol

COMMON AND IUPAC NAMES OF SOME ALCOHOLS

Compound	Common name	IUPAC name
$CH_3—OH$	Methyl alcohol	Methanol
$CH_3—CH_2—CH_2—OH$	*n*-Propyl alcohol	Propan-1-ol
$CH_3—\underset{\displaystyle OH}{\underset{|}{CH}}—CH_3$	Isopropyl alcohol	Propan-2-ol
$CH_3—CH_2—CH_2—CH_2—OH$	*n*-Butyl alcohol	Butan-1-ol
$CH_3—\underset{\displaystyle OH}{\underset{|}{CH}}—CH_2—CH_3$	sec-Butyl alcohol	Butan-2-ol
$\overset{\displaystyle CH_3}{\overset{|}{CH_2}}—\underset{\displaystyle OH}{\underset{|}{CH}}—CH_3$	Isobutyl alcohol	2-Methylpropan-1-ol
$CH_3—\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}—OH$	tert-Butyl alcohol	2-Methylpropan-2-ol
$\underset{\displaystyle OH}{\underset{|}{CH_2}}—\underset{\displaystyle OH}{\underset{|}{CH}}—\underset{\displaystyle OH}{\underset{|}{CH_2}}$	Glycerol	Propan-1,2, 3-triol

☑ SPECIAL TOPIC

ETHERS ($R^1–O–R^2$) CONTAIN AN ALKOXY GROUP (–OR)

The name ether refers to any compound that has two alkyl groups linked through an oxygen atom. 'Ether' is also used as an everyday name for diethyl ether, Et_2O. You might compare this use of the word 'ether' with the common use of the word 'alcohol' to mean ethanol. Diethyl ether is a highly flammable solvent that boils at only 35 C. It used to be used as an anaesthetic. Tetrahydrofuran (THF) is another commonly used solvent and is a cyclic ether.

► Another common laboratory solvent is called 'petroleum ether'. Don't confuse this with diethyl ether! Petroleum ether is in fact not an ether, but a mixture of alkanes. 'Ether', according to the Oxford English Dictionary, means 'clear sky, upper region beyond the clouds', and hence used to be used for anything light, airy, and volatile.

Compound	IUPAC name
CH_3OCH_3	Methoxymethane
$C_2H_5OC_2H_5$	Ethoxyethane
$CH_3OCH_2CH_2CH_3$	1-Methoxypropane

ETHERS

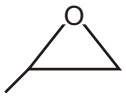
Common names of ethers are derived from the names of alkyl/aryl groups written as separate words in alphabetical order and adding the word 'ether' at the end. For example, $CH_3OC_2H_5$ is ethylmethyl ether.

COMMON AND IUPAC NAMES OF SOME ETHERS

Compound	Common name	IUPAC name
CH_3OCH_3	Dimethyl ether	Methoxymethane
$C_2H_5OC_2H_5$	Diethyl ether	Ethoxyethane
$CH_3OCH_2CH_2CH_3$	Methyl *n*-propyl ether	1-Methoxypropane
$C_6H_5OCH_3$	Methylphenyl ether (Anisole)	Methoxybenzene (Anisole)
$C_6H_5OCH_2CH_3$	Ethylphenyl ether (Phenetole)	Ethoxybenzene
$C_6H_5O(CH_2)_6 - CH_3$	Heptylphenyl ether	1-Phenoxyheptane
$CH_3O-CH(CH_3)-CH_3$	methyl isopropyl ether	2-Methoxypropane

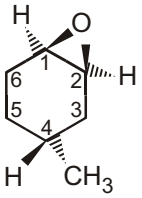
EPOXIDES

- Functional group is an epoxide, therefore suffix = –epoxide.
- The longest continuous chain is C3 therefore root **= prop.**
- Location of "alkene" is unambiguous, so no locant needed.

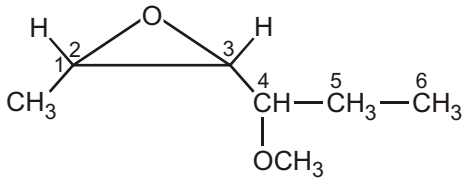


1,2-epoxypropane

One systematic method for naming epoxides is to name the rest of the molecule and use the term “epoxy” as a subsituent, giving the numbers of the two carbon atoms bonded to the epoxide oxygen.

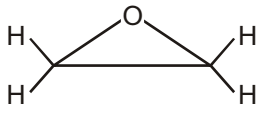


trans-1,2-epoxy-4-methylcyclohexane

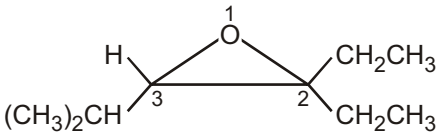


cis-2-3-epoxy-4-methoxyhexane

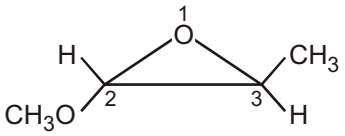
Another systematic method names epoxides as derivatives of the parent compound, ethylene oxide, using “oxirane” as the systematic name for ethylene oxide. In this system, the ring atoms of a heteroxyclic compound are numbered starting with the heteroatom and going the direction to give the lowest substituent numbers. The “epoxy” system names are also listed for comparison. Note that the numbering is different for the “epoxy” system names, which number the longest chain rather than the ring.



oxirane
1,2-epoxyethane



2,2-diethyl-3-isopropyloxirane
3,4-epoxy-4-ethyl-2-methylhexane



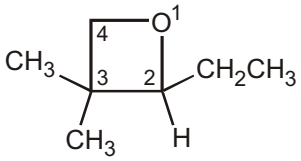
trans-2-methoxy-3-methyloxirane
1,2-epoxy-1-methoxypropane

☑ SPECIAL TOPIC

OXETANES

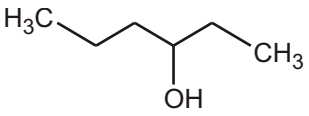
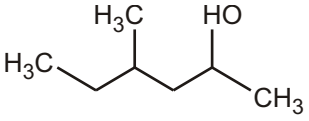
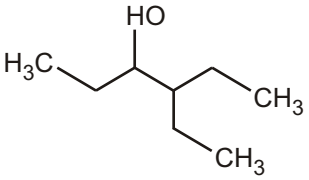
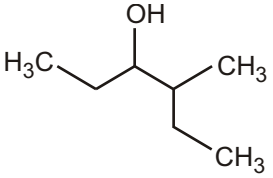
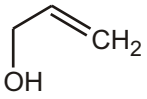
The least common cyclic ethers are the four-membered oxetanes. Because these four-membered rings are strained, they are more reactive than larger cyclic ethers and open-chain ethers. However they are not as reactive as the highly strained oxiranes (epoxides).

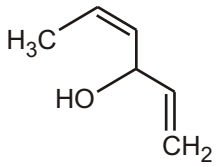
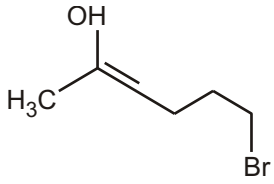
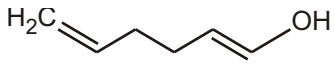
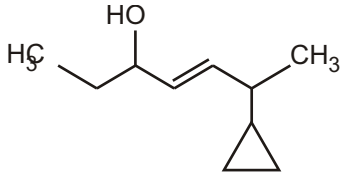
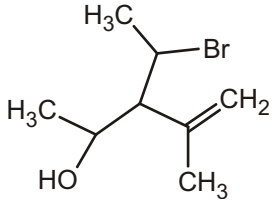
oxetane



2-ethyl-3,3-dimethyloxetane

WORK SHEET

S.No.	Compounds	Write IUPAC - Name
1.		
2.		
3.		
4.		
5.		

6.		
7.		
8.		
9.		
10.		

Answers

Work sheet

1. hexan-3-ol **2.** 4-methylhexan-2-ol **3.** 4-ethylhexan-3-ol

4. 4-methylhexan-3-ol **5.** prop-2-en-1-ol **6.** hexa-1,4-dien-3-ol

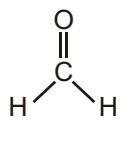
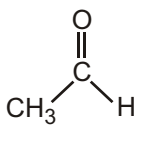
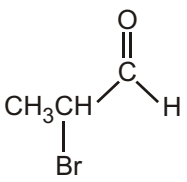
7. 6-bromohex-2-en-2-ol **8.** hexa-1,5-dien-1-ol **9.** 6-cyclopropylhept-4-en-3-ol

10. 3-(1-bromoethyl)-4-methylpent-4-en-2-ol

THE NOMENCLATURE OF ALDEHYDES

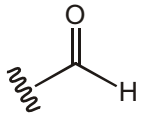
NAMING ALDEHYES

The systematic (IUPAC) name of an aldehyde is obtained by replacing in final “e” on the name of the parent hydrocarbon with “al.” For example. A one-carbon aldehyde is called methanal, and two-carbon aldehyde is called ethanal. The position of the carbonyl carbon does not have to be designated because it is always at the end of the parent hydrocarbon (or else the compound would not be an aldehyde). So it always has the 1-position.

			
systematic name:	methanal	ethanal	2-bromopropanal
common name :	formaldehyde	acetaldehyde	α-bromopropionaldehyde

Points to Remember

- –CHO represents:



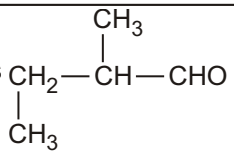
When we write aldehydes as R–CHO, we have no choice but to write in the C and H (because they're part of the functional group).

◎ Mistake to Avoid

- For drawing structures.

Another point: always write R–CHO and never R–COH, which looks too much like an alcohol.

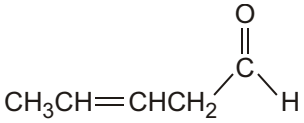
Solved Example

- The IUPAC name of is 

Ans. 2-methyl butanal

☞ If one of the functional groups is an alkene, suffix endings are used for both functional groups and the alkene functional group is stated first, with its "e" ending omitted to avoid two successive vowels.

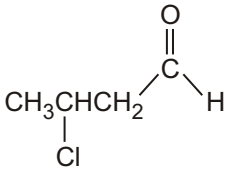
Solved Example

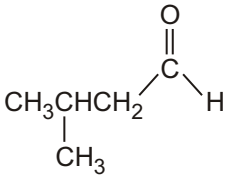
- 

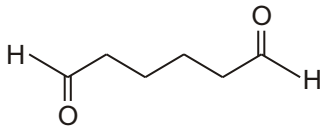
3-pentenal

☞ Note that the terminal "e" of the parent hydrocarbon is not removed in hexanedial (The "e" is removed only to avoid two successive vowels.)

Solved Example

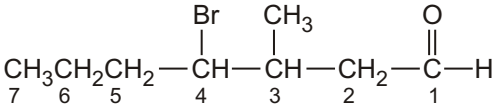




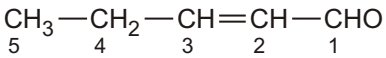


systematic name: 3-chlorobutanal | 3-methylbutanal | hexanedial

common name : β-chloropionaldehyde | isovaleraldehyde



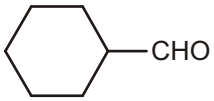
4-bromo-3-methylheptanal



2-pentenal or pent-2-enal

☞ If the aldehydic group is attached to a ring, then the suffix carbaldehyde is added to the full name of cyclohexane.

Example



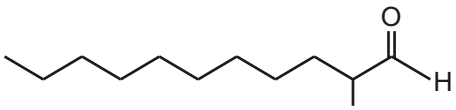
Cyclohexanecarbaldehyde

4-Nitrobenzenecarbaldehyde
or
4-Nitrobenzaldehyde

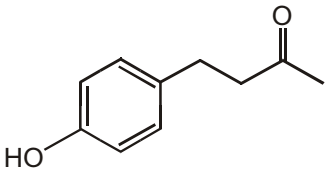
☑ SPECIAL TOPIC

SPECIAL TOPIC: ALDEHYDES (R–CHO) AND KETONES (R^1–CO–R^2) CONTAIN THE CARBONYL GROUP C O

Aldehydes can be formed by oxidizing alcohols—in fact the liver detoxifies ethanol in the bloodstream by oxidizing it first to acetaldehyde (ethanal, CH_3CHO). Acetaldehyde in the blood is the cause of hangovers. Aldehydes often have pleasant smells—2-methylundecanal is a key component of the fragrance of Chanel No 5^{TM}, and 'raspberry ketone' is the major component of the flavour and smell of raspberries.

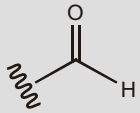


2-methylundecanal



"raspberry ketone"

► **—CHO represents :**



When we write aldehydes as R—CHO, we have no choice but to write in the C and H (because they're part of the functional group) — one important intance where you should ignore Guideline 3 for drawing structures.

Another point : always write R—CHO and never R—CHO, which looks too much like an alcohol.

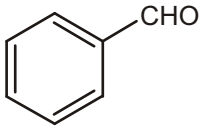
COMMON NAMES OF ALDEHYDE & KETONE ALDEHYDES :

- Often called by their common names instead of IUPAC names.
- Derived from the common names of the carboxylic acids by replacing the ending '–ic' of the acid with aldehyde.
- Location of the substituent in the carbon chain is indicated by the Greek letters , , , etc.

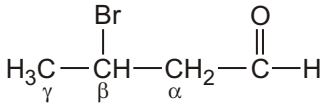
Example

CH_3CHO

Acetaldehyde



Benzaldehyde



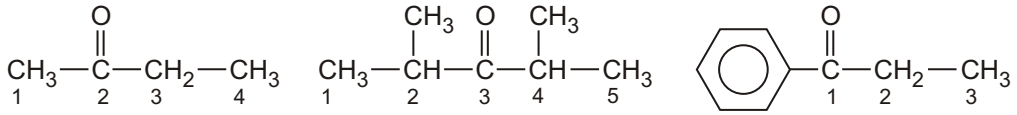
β-Bromobutyraldehyde

NOMENCLATURE OF KETONES

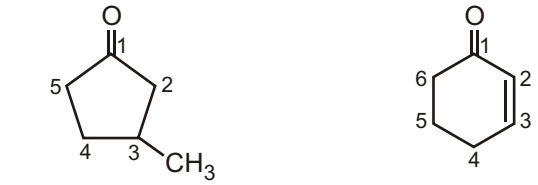
IUPAC NAMES

- For open-chain aliphatic aldehydes and ketones, IUPAC names are derived from the names of the corresponding alkanes by replacing the ending '–e' with '–al' and '–one' respectively.
- In the case of aldehydes, the longest chain is numbered starting from the carbon of the aldehydic group.
- In the case of ketones, the numbering begins from the end nearer to the carbonyl group.
- Substituents are prefixed in the alphabetical order along with the numerals indicating their positions in the carbon chain.
- Same rule is applicable to cyclic ketones.

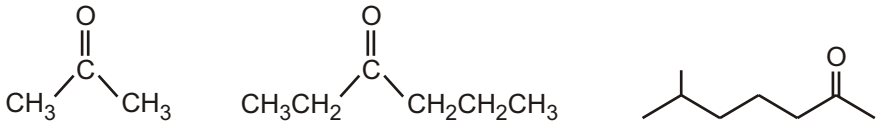
Solved Example



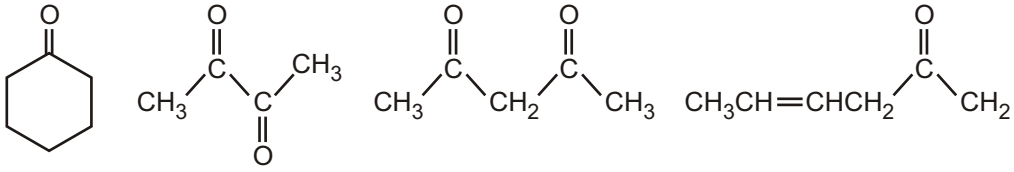
old IUPAC names: 2-butanone | 2,4-dimethyl-3-pentanone | 1-phenyl-1-propanone
new IUPAC names: butan-2-one | 2,4-dimethylpentan-3-one | 1-phenylpropan-1-one



3-methylcyclopentanone | 2-cyclohexenone, cyclohex-2-en-1-one



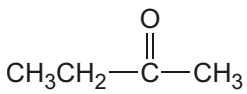
systematic name: propanone | 3-hexanone | 6-methyl-2-heptanone
common name : acetone
derived name : **dimethyl ketone** | **ethyl propyl ketone** | **isohexyl methyl ketone**



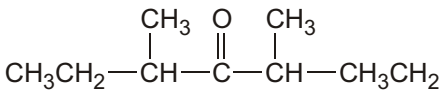
systematic name : cyclohexanone | butanedione | 2,4-pentanedione | 4-hexen-2-one
common name : acetylacetone

COMMON NAMES

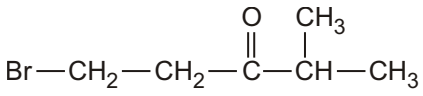
As with other classes of compounds, ketones and aldehydes are often called by common names instead of their systematic IUPAC names. Ketone common names are formed by naming the two alkyl groups bonded to the carbonyl group. Substituent locations are given using Greek letters, beginning with the carbon next to the carbonyl group.



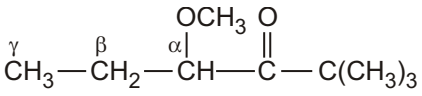
ethyl methylketone



di-sec-butyl ketone



bromoethyl isopropyl ketone

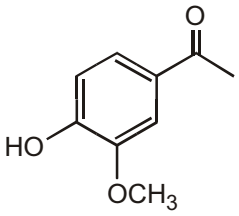


tert-butyl -methoxypropyl ketone

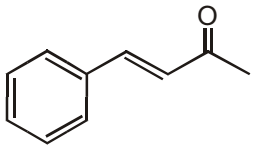
☑ SPECIAL TOPIC

SPECIAL TOPIC: SMELLS OF ALDEHYDE AND KETONES

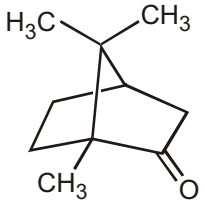
Many compounds found in nature have aldehyde or ketone functional groups. Aldehydes have pungent odors. Whereas ketones tend to smell sweet. Vanillin and cinnamaldehyde are examples of naturally occurring aldehydes. A whiff of vanilla extract will allow you to appreciate the pungent odor of vanillin. The ketones camphor and carvone are responsible for the characteristic sweet odoros of the leaves of camphor trees, spearmint leaves, and caraway seeds.



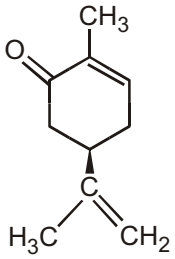
vanillin
vanilla flavoring



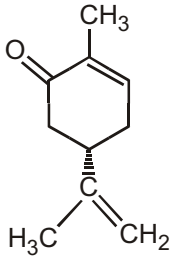
cinnamaldehyde
cinnamon flavoring



camphor

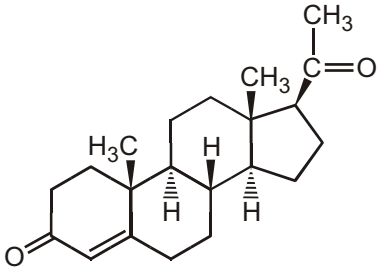


(R)-(–)-carvone
spearmint oil

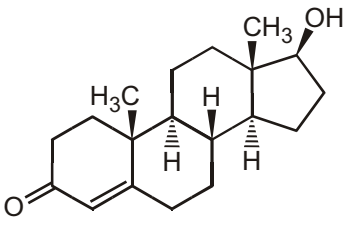


(S)-(+)-carvone
caraway speed oil

Progesterone and testosterone are two biologically important ketones that illustrate how a small difference in structure can be responsible for a large difference in biological activity. Both are sex hormones, but progesterone is synthesized primarily in the ovaries, where testosterone is synthesized primarily in the testes.



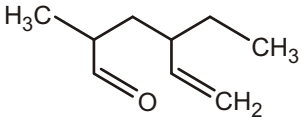
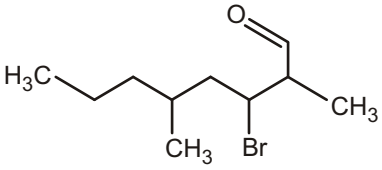
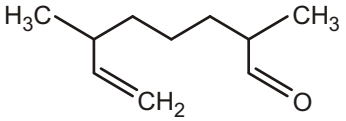
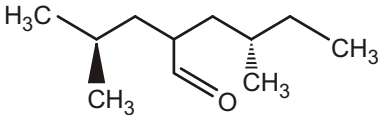
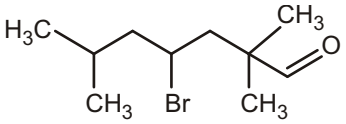
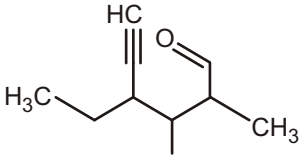
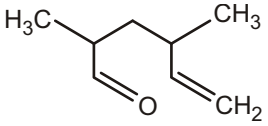
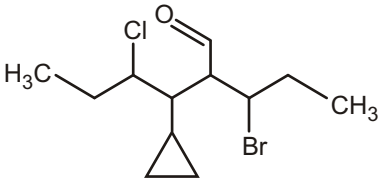
progesterone



testosterone

EXERCISE

WORK SHEET - 1

S.No.	Compounds	Write IUPAC - Name
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Answers

Work Sheet-1

1. 4-ethyl-2-methylhex-5-enal
2. 3-bromo-2,5-dimethyloctanal
3. 2,6-dimethyloct-7-enal
4. 4-methyl-2-(2-methylpropyl)hexanal
5. 4-bromo-2,2,6-trimethylheptanal
6. 4-ethyl-2,3-dimethylhex-5-ynal
7. 2,4-dimethylhex-5-enal
8. 2-(1-bromopropyl)-4-chloro-3-cyclopropylhexanal

❑❑❑❑