

4.5.5 Names, carbon counts and completed organic formulae

Name: _____ Class: _____ Date: _____

Total: 33 marks

KEY WORDS displayed formula • skeletal formula

Objective

Convert names into structural, displayed and skeletal formulae for carbonyls, acids, acyl chlorides and esters. Questions and completed answer drawings are original.

1 Key knowledge and worked examples

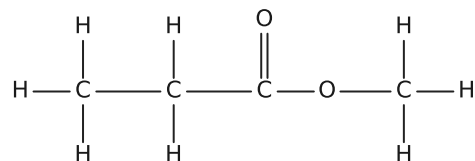
Count the carbonyl carbon as part of the named parent chain. An aldehyde ends in -CHO ; a ketone has carbon groups on both sides of C=O . A carboxylic acid ends in -COOH ; an acyl chloride in -COCl . An ester is R-CO-O-R' : its alkyl name comes from R' and its alkanoate name includes the carbonyl carbon on the acid side.

■ Worked name-to-structure route

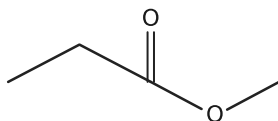
For methyl propanoate, the acid-side parent has three carbons including C=O ; the alcohol-side methyl adds one more. The condensed structural formula is $\text{CH}_3\text{CH}_2\text{COOCH}_3$, molecular formula $\text{C}_4\text{H}_8\text{O}_2$. Do not attach the methyl directly to carbonyl carbon: the ester oxygen must lie between it and the acid-side carbonyl.

Methyl propanoate

Displayed formula



Skeletal formula



A displayed formula shows every atom and bond. A skeletal formula uses unlabelled carbon ends/vertices with implied H to complete carbon valence; show O, Cl and any H bonded to oxygen explicitly. A double line to O is C=O , not another carbon atom. Check that each carbon has total bond order four and oxygen has its appropriate bonding.

2 Practice

2.1 Draw displayed and skeletal formulae for propanal. Give its condensed structural formula. [5]

2.2 Draw displayed and skeletal formulae for propanone. Give its condensed structural formula and explain the naming difference from propanal. [6]

2.3 Draw displayed and skeletal formulae for propanoic acid. Give its condensed structural formula. [5]

3 Exam-style questions

3.1 Draw displayed and skeletal formulae for propanoyl chloride. Give its condensed structural formula and state the organic product with water. [6]

3.2 An ester gives methanol and propanoic acid on acid hydrolysis. Name it, give its condensed structural formula, and draw its displayed and skeletal formulae. [6]

3.3 Give condensed structural formulae for ethyl ethanoate and methyl propanoate. Show that their molecular formulae are the same, explain their structural-isomer relationship and predict their different hydrolysis alcohols. [5]

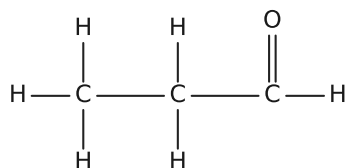
Solutions

Original marking guidance: B1 for each stated chemically correct feature.

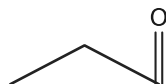
2.1 $\text{CH}_3\text{CH}_2\text{CHO}$.

Propanal

Displayed formula



Skeletal formula

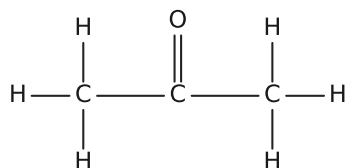


Displayed: B1 correct carbon skeleton/terminal carbonyl and B1 all H/bonds correct.
Skeletal: B1 three-carbon skeleton with terminal $\text{C}=\text{O}$ and B1 correct implied carbon valences.

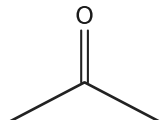
2.2 CH_3COCH_3 ; the -one suffix denotes an internal ketone carbonyl, whereas -al denotes the terminal aldehyde group.

Propanone

Displayed formula



Skeletal formula

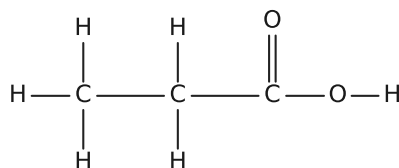


Displayed: B1 correct carbon skeleton/central carbonyl and B1 all H/bonds correct.
Skeletal: B1 three-carbon skeleton with internal $\text{C}=\text{O}$ and B1 correct implied carbon valences.

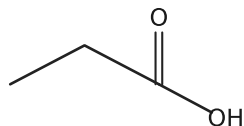
2.3 $\text{CH}_3\text{CH}_2\text{COOH}$.

Propanoic acid

Displayed formula



Skeletal formula

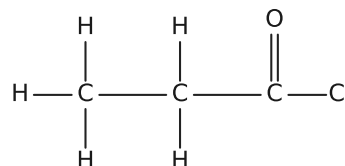


Displayed: B1 correct acid skeleton and B1 every atom/bond correct. Skeletal: B1 three-carbon acid-side skeleton and B1 $\text{C}=\text{O}$ plus explicitly shown OH.

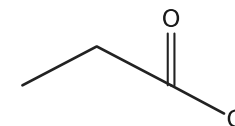
3.1 $\text{CH}_3\text{CH}_2\text{COCl}$; water gives propanoic acid, with HCl also formed.

Propanoyl chloride

Displayed formula



Skeletal formula

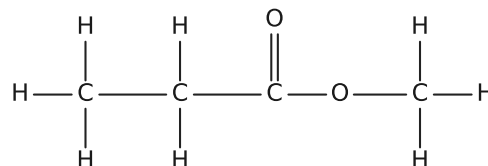


Displayed: B1 correct acyl skeleton and B1 all atoms/bonds correct. Skeletal: B1 three-carbon skeleton and B1 terminal $\text{C}=\text{O}/\text{Cl}$ connectivity.

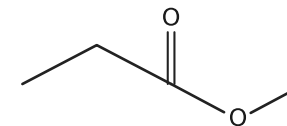
3.2 Methyl propanoate, $\text{CH}_3\text{CH}_2\text{COOCH}_3$.

Methyl propanoate

Displayed formula



Skeletal formula



Displayed: B1 correct three-carbon acid-side skeleton and B1 $-\text{CO}-\text{O}-\text{CH}_3$ with all H correct. Skeletal: B1 correct acid-side skeleton/ $\text{C}=\text{O}$ and B1 explicit ester O with one carbon on its methyl side.

3.3 $\text{CH}_3\text{COOCH}_2\text{CH}_3$ and $\text{CH}_3\text{CH}_2\text{COOCH}_3$. Both have $\text{C}_4\text{H}_8\text{O}_2$; same molecular formula but different atom connectivity makes them structural isomers. Their hydrolysis alcohols are ethanol and methanol respectively.