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

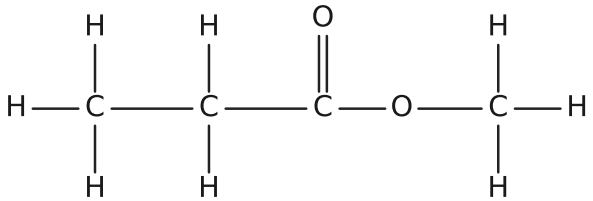
Count the carbonyl carbon as part of the named parent chain. An aldehyde ends in –CHO; a ketone has carbon groups on both sides of C=O. A carboxylic acid ends in –COOH; an acyl chloride in –COCl. An ester is R–CO–O–R′: its alkyl name comes from R′ and its alkanoate name includes the carbonyl carbon on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

■ Worked name-to-structure route

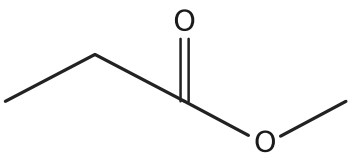
For methyl propanoate, the acid-side parent has three carbons including C=O; the alcohol-side methyl adds one more. The condensed structural formula is $CH_3CH_2COOCH_3$, molecular formula $C_4H_8O_2$. Do not attach the methyl directly to carbonyl carbon: the ester oxygen must lie between it and the 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]

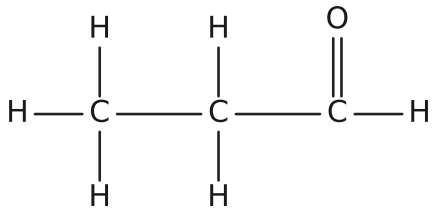
Solutions

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

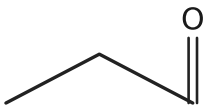
2.1 CH_3CH_2CHO.

Propanal

Displayed formula



Skeletal formula

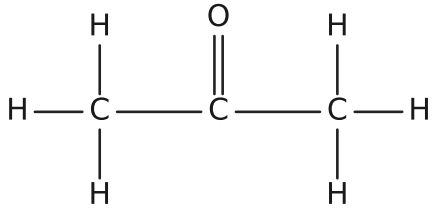


Displayed: B1 correct carbon skeleton/terminal carbonyl and B1 all H/bonds correct. Skeletal: B1 three-carbon skeleton with terminal C=O and B1 correct implied carbon valences.

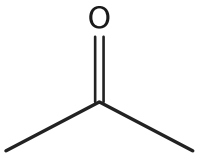
2.2 CH_3COCH_3; the –one suffix denotes an internal ketone carbonyl, whereas –al denotes the terminal aldehyde group.

Propanone

Displayed formula



Skeletal formula

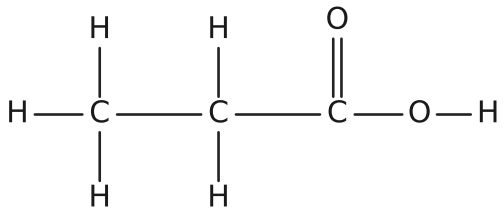


Displayed: B1 correct carbon skeleton/central carbonyl and B1 all H/bonds correct. Skeletal: B1 three-carbon skeleton with internal C=O and B1 correct implied carbon valences.

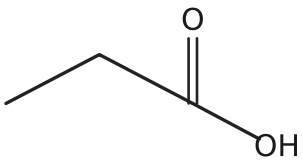
2.3 CH_3CH_2COOH.

Propanoic acid

Displayed formula



Skeletal formula

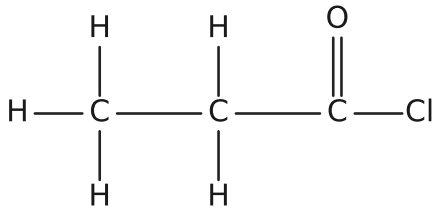


Displayed: B1 correct acid skeleton and B1 every atom/bond correct. Skeletal: B1 three-carbon acid-side skeleton and B1 C=O plus explicitly shown OH.

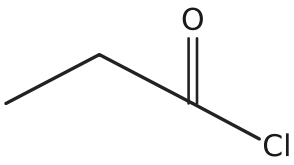
3.1 CH_3CH_2COCl; water gives propanoic acid, with HCl also formed.

Propanoyl chloride

Displayed formula



Skeletal formula

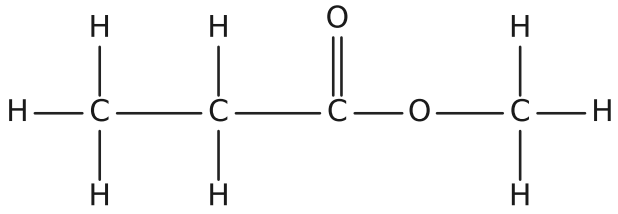


Displayed: B1 correct acyl skeleton and B1 all atoms/bonds correct. Skeletal: B1 three-carbon skeleton and B1 terminal C=O/Cl connectivity.

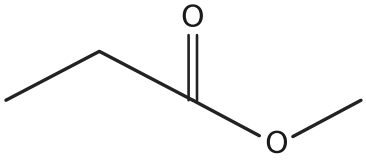
3.2 Methyl propanoate, $CH_3CH_2COOCH_3$.

Methyl propanoate

Displayed formula



Skeletal formula



Displayed: B1 correct three-carbon acid-side skeleton and B1 –CO–O–CH_3 with all H correct. Skeletal: B1 correct acid-side skeleton/C=O and B1 explicit ester O with one carbon on its methyl side.

3.3 $CH_3COOCH_2CH_3$ and $CH_3CH_2COOCH_3$. Both have $C_4H_8O_2$; same molecular formula but different atom connectivity makes them structural isomers. Their hydrolysis alcohols are ethanol and methanol respectively.