1 Introduction to Organic Chemistry Tutorial

Structure and naming

1 Give the IUPAC name for each compound.

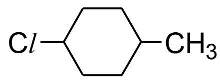
(a) $CH_3CH(CH_3)CH_2CH(OH)CH_3$

4-methylpentan-2-ol

(b) $CH_2{=}CHCH{=}CHBr$

1-bromobuta-1,3-diene

(c)



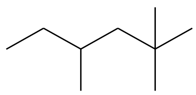
1-chloro-4-methylcyclohexane

(d) $CH_3CH(CO_2H)CH_2CH_3$

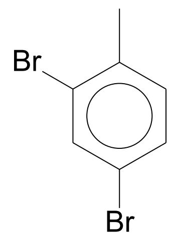
2-methylbutanoic acid

2 Draw the skeletal formula of each compound.

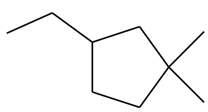
(a) 2,2,4-trimethylhexane



(b) 2,4-dibromomethylbenzene

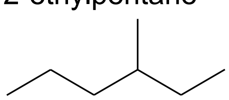


(c) 1-ethyl-3,3-dimethylcyclopentane



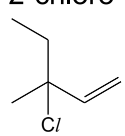
3 For each part, the name given is **incorrect**. Draw the skeletal formula for each and give its correct IUPAC name.

(a) 2-ethylpentane



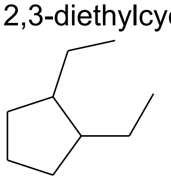
3-methylhexane

(b) 2-chloro-2-ethylbut-3-ene



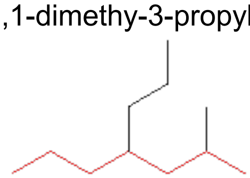
3-chloro -3-methylpent -1-ene

(c) 2,3-diethylcyclopentane



1,2-diethylcyclopentane

(d) 1,1-dimethy-3-propylhexane



2-methyl -**4**- propylheptane

Hybridisation

4 State the type of hybridisation of **each carbon** in each species.

(a) CH_3^- **sp³**

(b) CH_3CH_2OH **both sp³**

(c) CH_3CHO **sp³ and sp²**

(d) CH_3^+ **sp²**

(e)

C_1 to C_4 and C_7: sp^2; C_5, C_6 and C_8: sp^3

Type of reaction

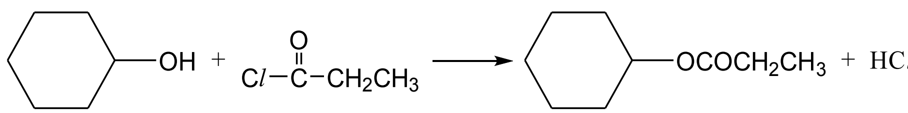
5 Classify each reaction as ***addition***, ***elimination***, ***condensation***, ***oxidation***, ***reduction*** or ***substitution***.

(a) $CH_3CH_3 + Br_2 \longrightarrow CH_2BrCH_3 + HBr$ ***substitution***

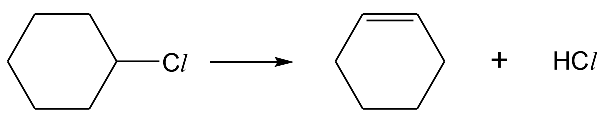
(b) $CH_2{=}CHCH_3 + Br_2 \longrightarrow BrCH_2CH_2BrCH_3$ ***addition***

(c) $CH_3CH_2CH_2OH + 2[O] \longrightarrow CH_3CH_2CO_2H + H_2O$ ***oxidation***

(d) $CH_3CO_2H + 2[H] \longrightarrow CH_3CHO + H_2O$ ***reduction***

(e) 

condensation

(f) 

elimination

6 [N08/I/19]

The bond lengths in buta-1,3-diene differ from those which might be expected. The carbon-carbon bond length in ethane is 0.154nm and in ethene is 0.134nm. The central single bond in buta-1,3-diene (C2-C3), however, is shorter than the single bond in ethane: it is 0.147nm.

$$\overset{1}{CH_2} \underset{0.134\text{nm}}{=\!=\!=} \overset{2}{CH} \underset{0.147\text{nm}}{-\!-\!-} \overset{3}{CH} \underset{0.134\text{nm}}{=\!=\!=} \overset{4}{CH_2}$$

What helps to explain this C2-C3 bond length?

A It is a sp^2-sp^2 overlap.

B It is a sp^2-sp^3 overlap.

C The electrons in the filled p orbitals on C2 and C3 repel each other.

D The sp^3-sp^3 bonding is pulled shorter by a p-p (π bond) overlap.

In ethane, the carbons car sp^3 hybridised, hence the single bond in ethane is formed from the overlap of sp^3 hybrid orbitals; while in buta-1,3-diene, the carbons are sp^2 hybridised, hence the C2 – C3 bond is formed from the overlap of sp^2 hybrid orbitals. Since sp^2 hybrid orbitals have higher s character, they are smaller and have greater degree of orbital overlap leading to a shorter bond length.

7 Methanal has the molecular formula of HCHO and contains an unsaturated carbon. The C=O functional group of methanal can be described as being joined by a **σ-bond** and a **π-bond**.

(a) Identify the type of hybridisation of C in methanal.

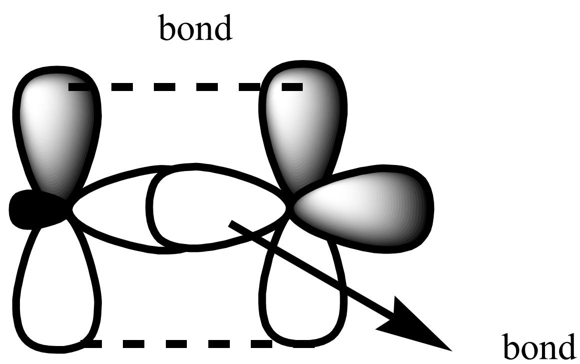
sp_2

(c) Hence, use a labelled diagram to show the orbitals that form the C=O bond in methanal.

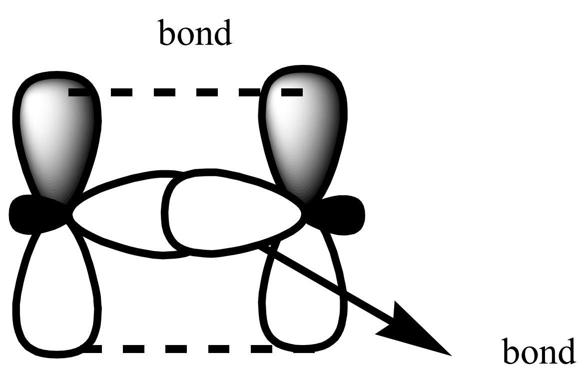
σ-bond is formed by the head-on overlap of sp^2 hybridised orbitals of the C and the p orbital of O, or the of sp^2 hybridised orbitals of the C and and O atoms

π-bond is formed by the sideways overlap of two p orbitals C and O atoms

Remind students : π-bond formation occurs only after a σ-bond is formed.



OR



Balancing equation for organic redox reaction

8 Balance each equation with either [O] or [H]. Add H_2O whenever necessary.

(a) $CH_3CH_2OH \longrightarrow CH_3CHO$

$\mathbf{CH_3CH_2OH + [O] \longrightarrow CH_3CHO + H_2O}$

(b) $CH_3CH_2CONH_2 \longrightarrow CH_3CH_2CH_2NH_2$

$\mathbf{CH_3CH_2CONH_2 + 4[H] \longrightarrow CH_3CH_2CH_2NH_2 + H_2O}$

(c) $CH_3CH{=}CHCH_3 \longrightarrow 2CH_3CO_2H$

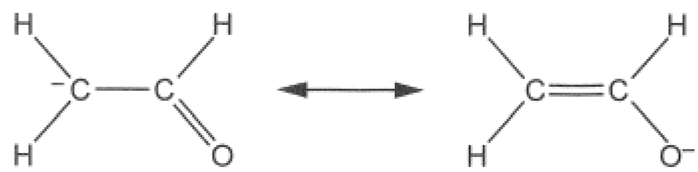
$\mathbf{CH_3CH{=}CHCH_3 + 4[O] \longrightarrow 2CH_3CO_2H}$

(d) $CH_3CO_2CH_3 \longrightarrow CH_3CH_2OH + CH_3OH$

$\mathbf{CH_3CO_2CH_3 + 4[H] \longrightarrow CH_3CH_2OH + CH_3OH}$

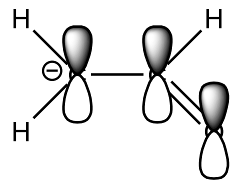
Drawing Resonance Structures

9 [N22/P2/5d(i) and (ii)]
The enolate ion can be represented by two different structures, W and V, as shown in the figure below. The arrow ↔ indicates that the actual structure of the enolate ion is somewhere between these two structures, with the negative charge delocalised over both the oxyen and carbon atoms.



W **V**

(a) Sugges how the delocalisation of electrons occur in an enolate ion.



The p orbitals of the 2 C and O atoms are aligned and sideway overlap with one another in a continous overlap.

(b) Deduce the number of delocalised electrons in an enolate ion.

4 electrons.

Electron flow in Reaction Mechanism

10 [N22/P3/3e]
Benzoyl peroxide, $(C_6H_5CO)_2O_2$, can be used to treat some skin conditions. It can be prepared by treating benzoyl chloride with barium peroxide.

$$2C_6H_5COCl + BaO_2 \rightarrow (C_6H_5CO)_2O_2 + BaCl_2$$

The O–O bond in peroxide is weak and undergoes homolytic fission.

Use curly arrow notation to show the equation for the homolytic fission of $(C_6H_5CO)_2O_2$