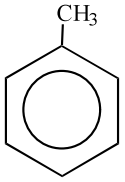
Set 25: Reactions of organic compounds

1. (a) $CH_3CH_2CH_3 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

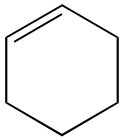
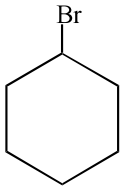
(b)  $+ 9O_2 \rightarrow 7CO_2 + 4H_2O$

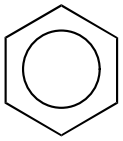
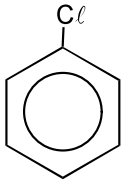
2. (a) $CH_4 + C\ell_2 \rightarrow CH_3C\ell + HC\ell$
chloromethane

(b) $CH_2{=}CH_2 + Br_2 \rightarrow BrCH_2CH_2Br$
1,2-dibromomethane

(c) $CH_3CH_2{=}CH_2CH_3 + H_2O \rightarrow CH_3CH_2\underset{\displaystyle OH}{\underset{|}{C}}HCH_3$
butan-2-ol

(d) $CH_2{=}CH_2CH_3 + H_2 \rightarrow CH_3CH_2CH_3$
propane

(e)  $+ HBr \rightarrow$ 
bromocyclohexene

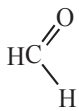
(f)  $+ C\ell_2 \rightarrow$  $+ HC\ell$
chlorobenzene

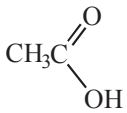
3. (a) ethane and water.
$CH_2{=}CH_2 + H_2O \rightarrow CH_3CH_2OH$

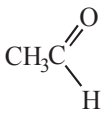
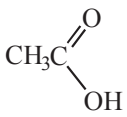
(b) Step 1: methane, chlorine, ultraviolet light.
$CH_4 + C\ell_2 \rightarrow CH_3C\ell + HC\ell$
Step 2: chloromethane, fluorine and ultraviolet light.
$CH_3C\ell + F_2 \rightarrow CH_2C\ell F + HF$

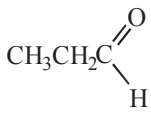
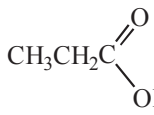
(c) Step 1: ethyne and chlorine.
$HC{\equiv}CH + C\ell_2 \rightarrow CHC\ell{=}CHC\ell$
Step 2: add more chlorine
$CHC\ell_2{=}CHC\ell_2 + C\ell_2 \rightarrow CHC\ell_2CHC\ell_2$

(d) Step 1: ethyne and chlorine.
$HC{\equiv}CH + HC\ell \rightarrow CH_2{=}CHC\ell$
Step 2: chloroethane and HBr
$CH_2{=}CHC\ell + HC\ell \rightarrow CH_3CHC\ell Br$

4. (a) $CH_3OH \rightarrow$  $+ 2H^+ + 2e^-$

(b) $CH_3CH_2OH + H_2O \rightarrow$  $+ 4H^+ + 4e^-$

(c)  $+ H_2O \rightarrow$  $+ 2H^+ + 2e^-$

(d)  $+ H_2O \rightarrow$  $+ 2H^+ + 2e^-$

(e) $CH_3CH(OH)CH_3 \rightarrow CH_3C(=O)CH_3 + 2H^+ + 2e^-$

(f) $CH_3CH(OH)CH_2CH_3 \rightarrow CH_3C(=O)CH_2CH_3 + 2H^+ + 2e^-$

5. (a) $5\,CH_3CH_2CH_2CH_2C(=O)H + 2MnO_4^- + 6H^+ \rightarrow 5\,CH_3CH_2CH_2CH_2C(=O)OH + 2Mn^+ + 3H_2O$
pentanoic acid

(b) $5\,CH_3CH_2CH_2OH + 4MnO_4^- + 12H^+ \rightarrow 5\,CH_3CH_2C(=O)OH + 4Mn^+ + 11H_2O$
propanoic acid

(c) $5\,CH_3CH(OH)CH_3 + 2MnO_4^- + 6H^+ \rightarrow 5\,CH_3C(=O)CH_3 + 2Mn^+ + 8H_2O$
propanone

(d) $3CH_3CH_2CH_2CH_2OH + Cr_2O_7^{2-} + 8H^+ \rightarrow 3\,CH_3CH_2CH_2C(=O)H + 2Cr^{3+} + 7H_2O$
butanal

(e) $3\,CH_3C(=O)H + Cr_2O_7^{2-} + 8H^+ \rightarrow 3\,CH_3C(=O)OH + 2Cr^{3+} + 4H_2O$
ethanoic acid

(f) $3\,CH_3OH + 2Cr_2O_7^{2-} + 16H^+ \rightarrow 3\,HC(=O)OH + 4Cr^{3+} + 11H_2O$
methanoic acid

(g) $3\,CH_3CH(OH)CH_2CH_3 + Cr_2O_7^{2-} + 8H^+ \rightarrow 3\,CH_3C(=O)CH_2CH_3 + 2Cr^{3+} + 7H_2O$
butan-2-one

(h) $5CH_3CH_2CH_2OH + 2MnO_4^- + 6H^+ \rightarrow 5\,CH_3CH_2C(=O)H + 2Mn^+ + 8H_2O$
propanal

6. (a) $2CH_3OH + 2Na \rightarrow H_2 + 2\ CH_3O^- + 2Na^+$ or $2CH_3ONa$
methoxide ion

OR

$2CH_3OH + 2Na \rightarrow H_2 + 2\ CH_3ONa$ (sodium methoxide)

(b) $2\,CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCH_3 + 2Na \rightarrow H_2 + 2\,CH_3\underset{\displaystyle ONa}{\underset{|}{C}}HCH_3$ sodium propan-2-oxide

(c) $CH_3CH_2C(=O)OH + CH_3CH_2CH_2CH_2OH \xrightarrow{H^+} CH_3CH_2C(=O)OCH_2CH_2CH_2CH_3 + H_2O$
butyl propanoate

(d) $HC(=O)OH + CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCH_3 \rightarrow HC(=O)O\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3 + H_2O$
2-propyl methanoate

(e) $CH_3CH_2C(=O)OH + OH^- \rightarrow CH_3CH_2C(=O)O^- + H_2O$
propanoate ion

(f) $CH_3C(=O)O^- + H^+ \rightarrow CH_3C(=O)OH$ ethanoic acid

7. (i) butan-2-ol, and acidified MnO_4^- or acidified $Cr_2O_7^{2-}$

$5\,CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCH_2CH_3 + 2MnO_4^- + 6H^+ \rightarrow 5\,CH_3\overset{\displaystyle O}{\overset{\|}{C}}CH_2CH_3 + 2Mn^+ + 8H_2O$

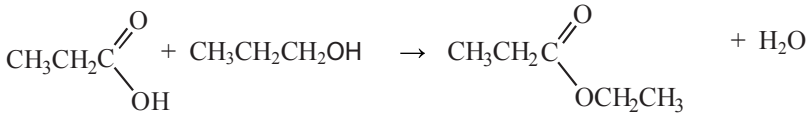
(ii) methane, CH_4, and chlorine. $CH_4 + C\ell_2 \rightarrow CH_3C\ell + HC\ell$ then $CH_3C\ell + C\ell_2 \rightarrow CH_2C\ell_2 + HC\ell$

finally $CH_2C\ell_2 + C\ell_2 \rightarrow CHC\ell_3 + HC\ell$

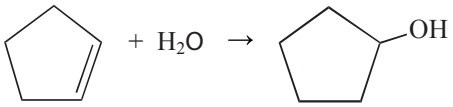
(iii) pentan-1-ol, $CH_3CH_2CH_2CH_2CH_2OH$, and acidified MnO_4^- or acidified $Cr_2O_7^{2-}$.

$5CH_3CH_2CH_2CH_2CH_2OH + 4MnO_4^- + 12H^+ \rightarrow 5CH_3CH_2CH_2CH_2C(=O)OH + 4Mn^+ + 11H_2O$

(iv) propanoic acid, propan-1-ol, $CH_3CH_2CH_2OH$ and sulfuric acid.



(v) cyclopentene and water.



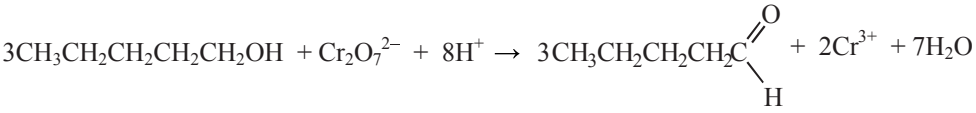
(vi) hex-2-ene, $CH_3CH{=}CHCH_2CH_2CH_3$ and bromine.

$CH_3CH{=}CHCH_2CH_2CH_3 + Br_2 \rightarrow CH_3CHBrCHBrCH_2CH_2CH_3$

(vii) propene, $CH_3CH{=}CH_2$ and hydrogen chloride.

$CH_3CH{=}CH_2 + HC\ell \rightarrow CH_3CHC\ell CH_3$

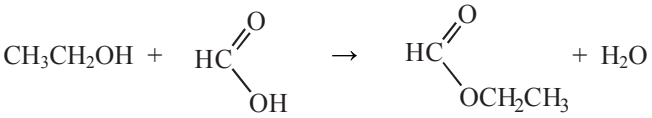
(viii) pentan-1-ol, $CH_3CH_2CH_2CH_2CH_2OH$, and acidified $Cr_2O_7^{2-}$ in limited quantities.



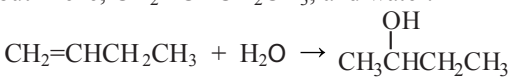
(ix) methanol, CH_3OH and sodium.

$2CH_3OH + 2Na \rightarrow H_2 + 2CH_3O^- + 2Na^+$

(x) ethanol, CH_3CH_2OH, methanoic acid and sulfuric acid.



(xi) but-1-ene, $CH_2{=}CHCH_2CH_3$, and water.



(xii) benzene, chlorine and a catalyst such as $A\ell C\ell_3$.