Polymers (Part 2) – Reactions of Functional Groups - Tutorial

Alkanes

1 **X** and **Y** have a molecular formula of C_4H_9Br. Both **X** and **Y** can be formed from butane by the following reaction.

$$CH_3CH_2CH_2CH_3 \longrightarrow \mathbf{X} + \mathbf{Y}$$

(a) State the type of reaction undergone in the above reaction.

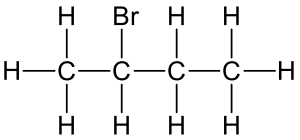
Substitution

(b) Suggest reagents and conditions necessary for the above reaction.

Limited **Br_2, UV**

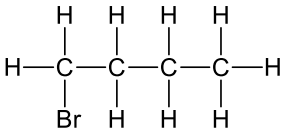
(c) Suggest the structural formula of **X** and **Y**.

Structure of **X**:



(or $CH_3CHCH_2CH_3$ with Br)

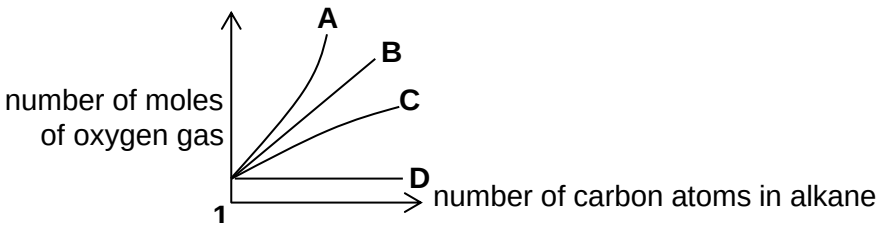
Structure of **Y**:



(or $CH_2CH_2CH_2CH_3$ with Br)

X and Y are interchangeable

2 The complete combustion for alkane to produce carbon dioxide and water is an important exothermic reaction. Which line on the graph shows the relationship between the number of carbon atoms in the alkane and the number of moles of oxygen gas needed for complete combustion of the alkane?



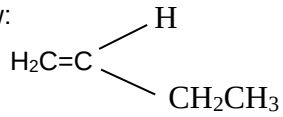
Ans : B

$C_xH_y + (x + \frac{y}{4}) \longrightarrow xCO_2 + \frac{y}{2} H_2O$

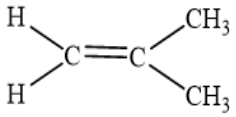
As number of carbon (x) increases, number of O_2 required for combustion increases proportionately

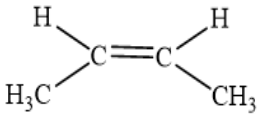
Alkenes

3 One of the four isomers of C_4H_8 is shown below:

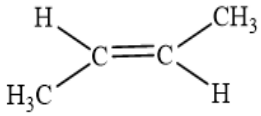
A 

(a) Draw the other 3 isomers of C_4H_8.





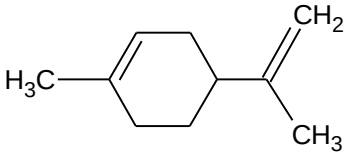
cis



trans

(b) State which isomers are *cis-trans* isomers.

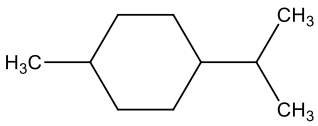
4 Limonene occurs in oil of lemons and is used to flavour citrus drinks.



Limonene

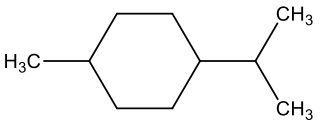
Give the structural formulae of the organic products, when limonene reacts with

(a) $H_2(g)$

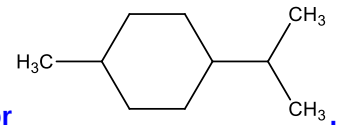


Reduction of alkene C=C to alkane (each C of C=C gain 1 H)

(b) Describe a simple chemical test by which you could distinguish the following pairs of compounds. State the observation for the test and write equation for the reaction.

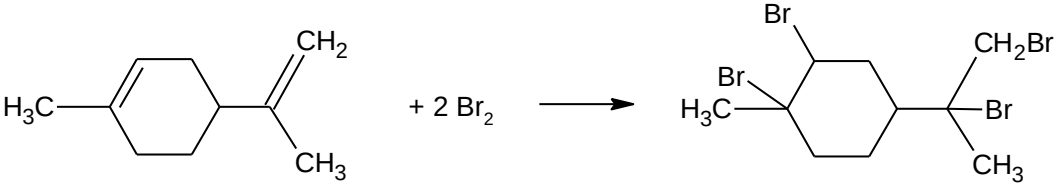
Limonene and 

Add **Br_2 in CCl_4 (inert organic solvent)**. **Orange red** Br_2 is **decolourised** for limonene, **but**



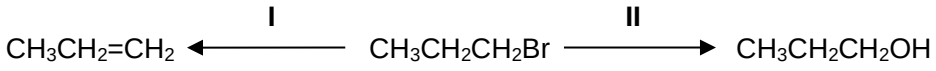
not for .

Equation:



Halogenoalkanes

5 The following reaction scheme shows the various reactions which bromopropane undergoes.



(i) State the type of reactions for steps **I** and **II**.

Step I : Elimination

Step II : Substitution

(ii) State the reagent and condition for steps **I** and **II**.

Step I : NaOH (or KOH) in ethanol, heat

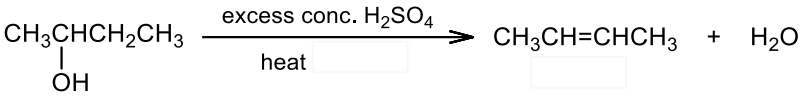
Step II : NaOH (or KOH) (aq), heat

Alcohol

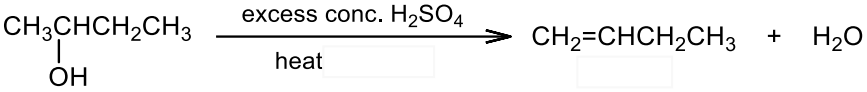
6 **(i)** Suggest the structural formula of the **product** of the following reactions and ***balance the equations.***

(ii) State the ***type of reaction*** undergone in each case.

(a)

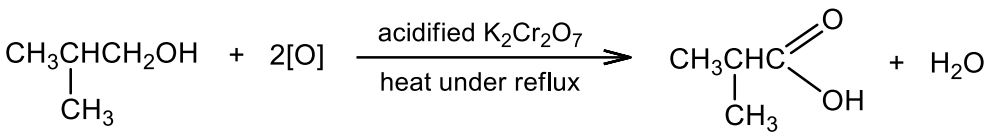


OR



Elimination

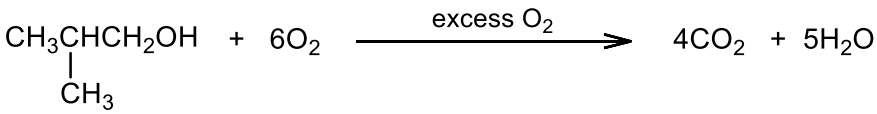
(b)



primary alcohol

Oxidation

(c)

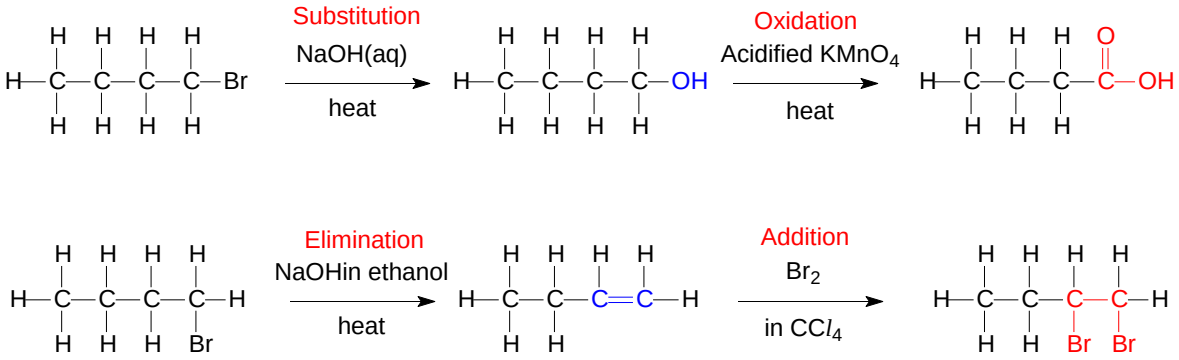


primary alcohol

Combustion

7 Suggest the intermediates and products formed during the following reactions of 1-bromobutane.

- reaction with aqueous NaOH, heat, followed by acidified $KMnO_4$, heat under reflux.
- reaction with NaOH in ethanol, heat, followed by Br_2 in CCl_4.



Aldehyde and Ketone

8 Compound **X** has the following structure:

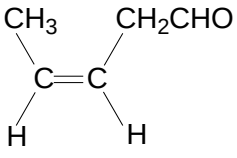
$CH_3CH=CHCH_2CHO$

(a) Name the functional groups present in **X**.

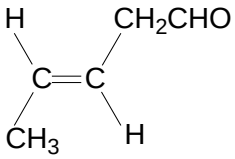
Alkene (C=C) and aldehyde (CHO, )

(b) Identify the type of stereoisomerism exhibited by **X** and draw diagrams to illustrate this isomerism exhibited.

cis-trans isomerism (must show trigonal planar around each C of C=C)



cis

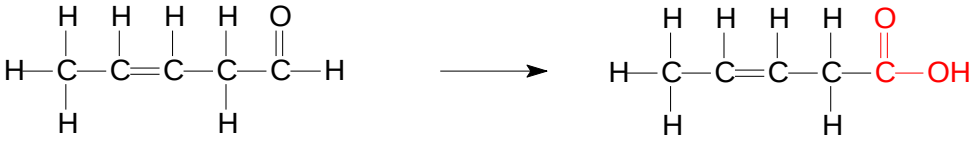


trans

(c) Draw the structural formula of the organic products formed when compound **X** reacts with the following reagents separately and state the type of reaction involved:

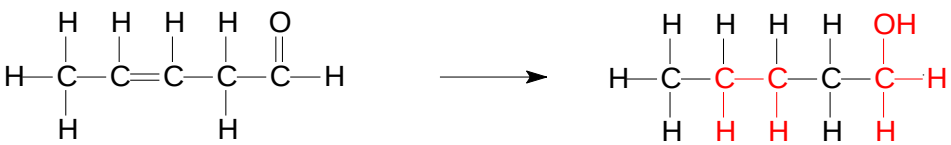
(i) acidfied $K_2Cr_2O_7$, heat under reflux

Oxidation of aldehyde to carboxylic acid



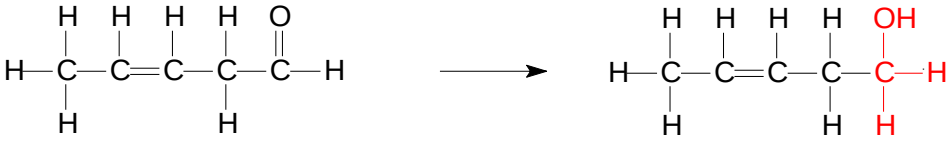
(ii) H_2, in the presence of catalyst, heat

Reduction of alkene to alkane and reduction of aldehyde to primary alcohol



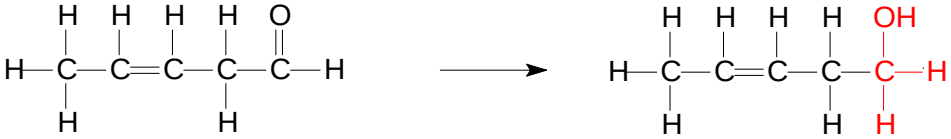
(iii) $LiAlH_4$, dry ether

Reduction of aldehyde to primary alcohol



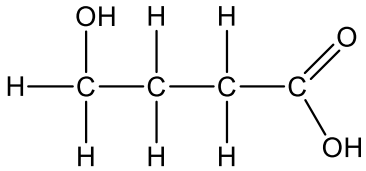
(iv) $NaBH_4$, methanol

Reduction of aldehyde to primary alcohol

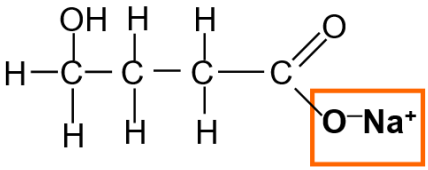


Carboxylic Acid

9 Draw the structure of the **organic product(s)** that is likely to be formed when a compound, with the formula as given below, reacts, if at all, with the following reagents. State the **type(s) of reaction** undergone (if any) for each reagent used.

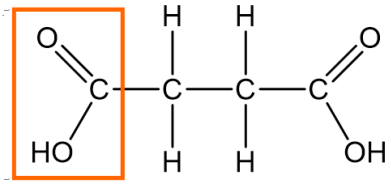


(a) aqueous NaOH



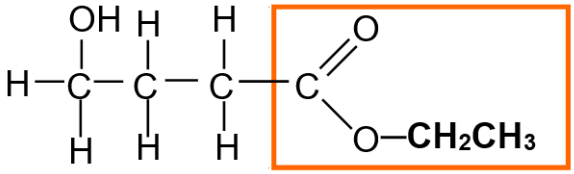
Acid-base reaction (carboxylic acid is acidic)

(b) $K_2Cr_2O_7$(aq), H_2SO_4 (aq), heat under reflux



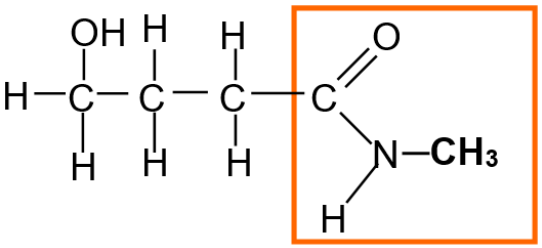
Oxidation (primary alcohol oxidized to carboxylic acid)

(c) CH_3CH_2OH, a few drops of conc. H_2SO_4, heat under reflux



Condensation (carboxylic acid with alcohol to form ester)

(d) CH_3NH_2, in the presence of DCC

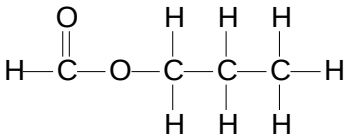


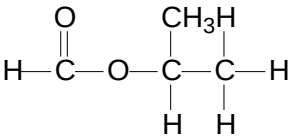
Condensation (carboxylic acid with alcohol to form ester)

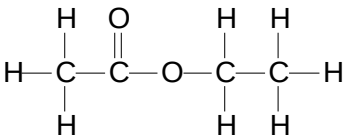
Ester and Amide

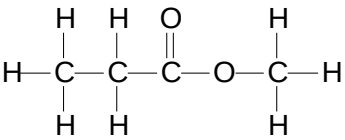
10 There are four ester isomers with the molecular formula $C_4H_8O_2$.

(a) Give the structural formulae of all these isomers.

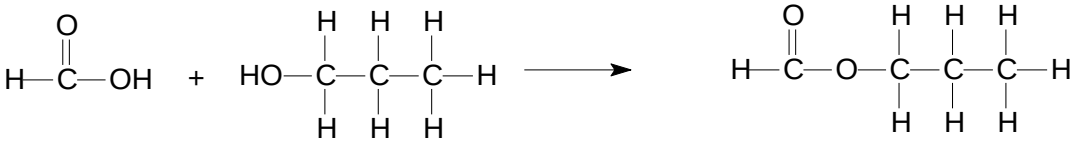


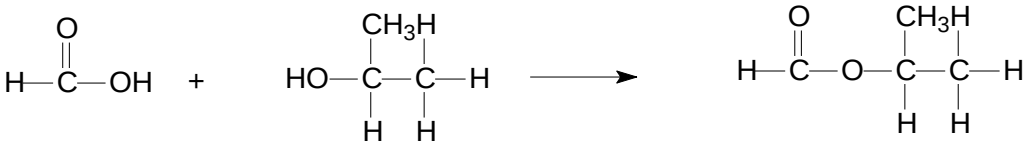


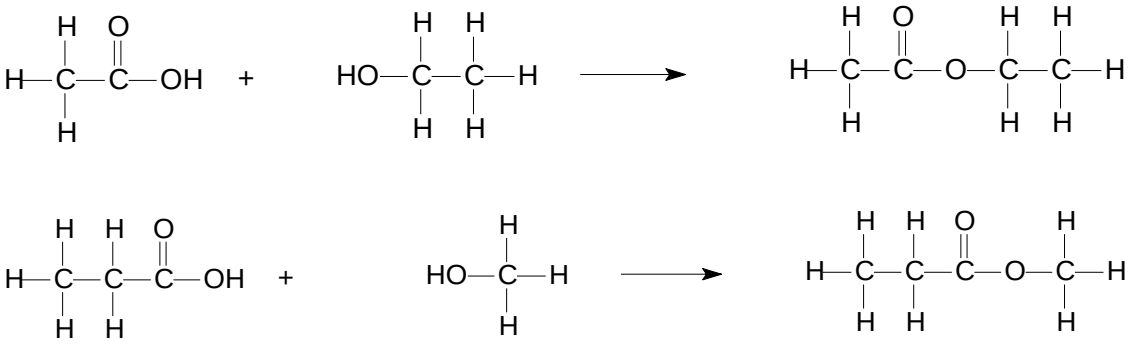




(b) For each of the isomer, state the carboxylic acid and alcohol from which the ester is formed.







11 Give the products for each of the following reactions.

(a) $CH_3CH_2CO_2CH_3$, HC*l*(aq), heat

$$CH_3CH_2CO_2CH_3 \ + \ \mathbf{H_2O} \xrightarrow{\text{heat under reflux}} \mathbf{CH_3CH_2COOH \ + \ CH_3OH}$$

Type of reaction: **Acid hydrolysis**

(b) $CH_3CO_2CH_2CH_3$, NaOH(aq), heat

$$CH_3CO_2CH_2CH_3 \ + \ \mathbf{NaOH} \xrightarrow{\text{heat under reflux}} \mathbf{CH_3CO_2^-Na^+ \ + \ CH_3CH_2OH}$$

Type of reaction: **Alkaline hydrolysis**

(c) $CH_3CH_2CONH_2$, HC*l*(aq), heat

$$CH_3CH_2CONH_2 \ + \ HCl(aq) \ + \ \mathbf{H_2O} \xrightarrow{\text{heat under reflux}} \mathbf{CH_3CH_2COOH \ + \ NH_4^+Cl^-}$$

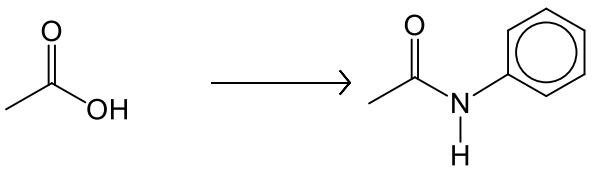
Type of reaction: **Acid hydrolysis**

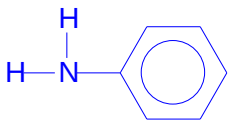
(d) $CH_3CH_2CONHCH_3$, NaOH(aq), heat

$$CH_3CH_2CONHCH_3 \ + \ NaOH(aq) \xrightarrow{\text{heat under reflux}} \mathbf{CH_3CH_2COO^-Na^+ \ + \ CH_3NH_2}$$

Type of reaction: **Alkaline hydrolysis**

12 Suggest the reagent and condition to form the following organic product from the given starting organic molecule.





, DCC