

16. Hydroxy compounds

16.1 Alcohols

Paper 2

Question Paper

- 1 (c) **Y** is a structural isomer of **W**.

Both **W** and **Y** produce colourless bubbles when sodium is added to them.

Y does **not** react when heated with acidified $\text{K}_2\text{Cr}_2\text{O}_7$.

Y does **not** react when warmed with alkaline $\text{I}_2(\text{aq})$.

- (i) Name the functional group present in **Y**.

..... [1]

- (ii) Complete the equation to describe the reaction of **W** or **Y** with sodium.

..... $\text{C}_4\text{H}_{10}\text{O}$ + Na → [1]

- (iii) Draw the structure of **Y**.

[1]

- 2 Propanone, CH_3COCH_3 , is an important organic reagent. Fig. 4.1 shows some reactions of propanone and its derivatives.

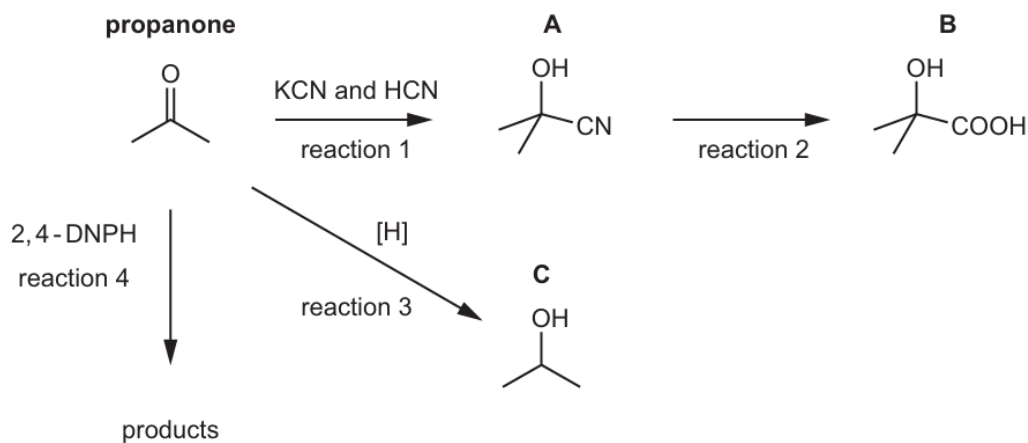


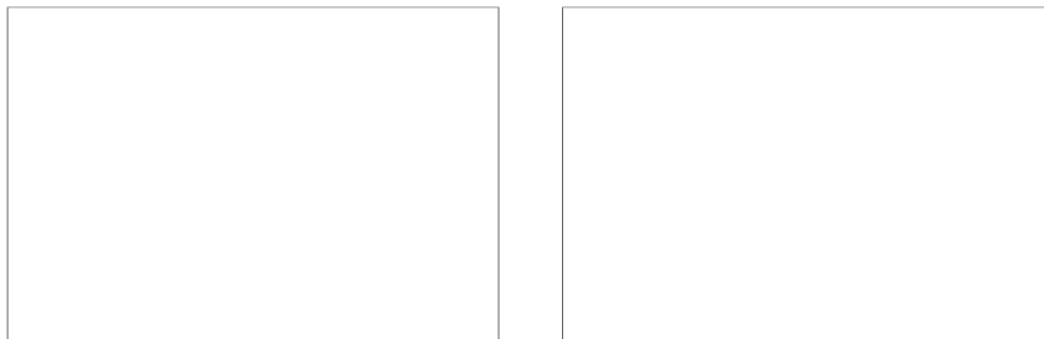
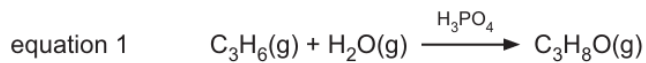
Fig. 4.1

- (b) Suggest the reagents and conditions for reaction 2.

..... [1]

3 (b) H_2O reacts with both inorganic and organic compounds.

(iii) Draw the structures of the two alcohols formed in the reaction shown in equation 1.



[2]

(iv) Explain why alcohols are less acidic than water.

.....

 [2]

4 V is a colourless liquid.

(b) V reacts to form Z in a single reaction, as shown in Fig. 4.2.

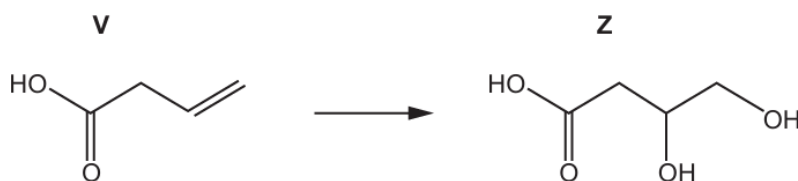


Fig. 4.2

(i) Suggest the reagent and conditions needed to form Z from V.

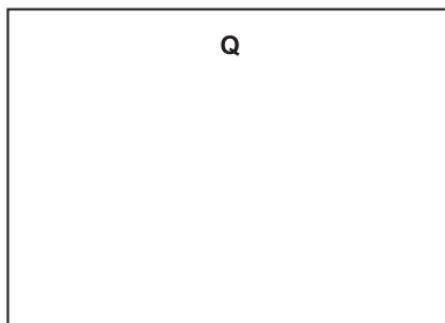
..... [1]

(ii) Deduce the empirical formula of Z.

..... [1]

- (c) **Q** contains the elements carbon, hydrogen and oxygen only. It is a saturated molecule with no branching in its carbon backbone.
Q contains only one functional group.
 The relative molecular mass of **Q** is 88.
 No effervescence is seen when Na_2CO_3 is added to **Q**.
 Effervescence is seen when sodium is added to **Q**.
Q reacts with alkaline $\text{I}_2(\text{aq})$ to form a yellow precipitate.

Draw the structure of **Q** in the box.



[2]

- 5 Fig. 3.1 describes a sequence of reactions that can be used to produce a food additive, compound **Y**, from $\text{CH}_3\text{CH}_2\text{Cl}$.

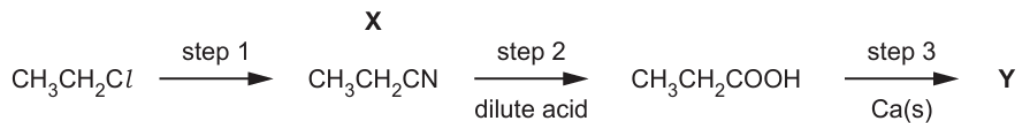


Fig. 3.1

- (b) $\text{CH}_3\text{CH}_2\text{COOH}$ can also be formed from propan-1-ol and potassium dichromate(VI).
 State the conditions required.

..... [1]

- 6 (e) The structure of glucose, $C_6H_{12}O_6$, is shown in Fig. 3.2.

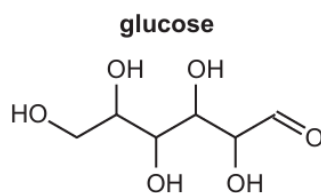


Fig. 3.2

- (i) Complete Table 3.1 to identify the number of primary, secondary and tertiary alcohol groups present in the structure shown in Fig. 3.2.

Table 3.1

type of alcohol group	primary	secondary	tertiary
number of groups			

[1]

- (ii) Separate samples of aqueous glucose are tested with the reagents shown in Table 3.2.

Complete Table 3.2 with the observation for each reaction.

Write "no reaction" if applicable.

Table 3.2

reagent and conditions	observation with glucose
acidified $KMnO_4(aq)$ and warm	
Fehling's reagent and warm	
alkaline $I_2(aq)$ and warm	

[3]

- 7** Some of the common chlorides of Period 3 elements are shown in the list.



- (c) PCl_5 reacts with alcohols to form chloroalkanes.

- (i) Identify this type of reaction.

..... [1]

- (ii) Draw the structure of the organic product formed in the reaction of an excess of PCl_5 with butane-1,3-diol.

[1]

- 8 Lactones are cyclic esters. Under suitable conditions, lactones form from molecules that have both an alcohol and a carboxylic acid functional group.
Equation 1 shows an example of the formation of a lactone.

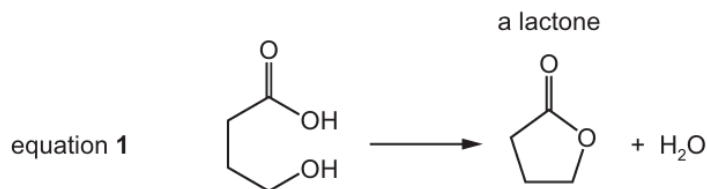


Fig. 5.1 shows the synthesis of lactone **P** from compound **M**.

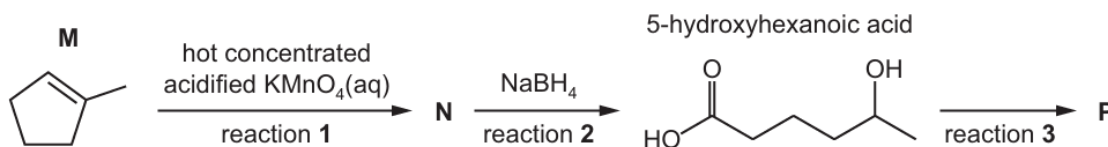


Fig. 5.1

- (a) (i) **M** reacts with hot concentrated acidified $\text{KMnO}_4(\text{aq})$ to form **N**, $\text{C}_6\text{H}_{10}\text{O}_3$, in reaction 1.

Draw the structure of **N**.

[1]

- 9 (c) A sample of propan-1-ol reacts with concentrated sulfuric acid to form propene.

Identify the role of concentrated sulfuric acid in this reaction.

..... [1]

- (d) Alcohol **Y** reacts completely when warmed with acidified $\text{Cr}_2\text{O}_7^{2-}$ to form **Z**.

Z is distilled from the reaction mixture as soon as it is made.

Tollens' reagent is added to a sample of **Z** and warmed. A silver mirror forms.

- (i) Name the type of reaction that occurs when **Y** reacts to form **Z**.

..... [1]

10 **S** is a secondary alcohol with molecular formula $C_4H_{10}O$.

(b) **S** is converted to **V** in a three-step reaction sequence.

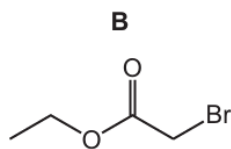


In step 1, the secondary alcohol **S** reacts with PBr_3 to produce **T**, which has molecular formula C_4H_9Br .

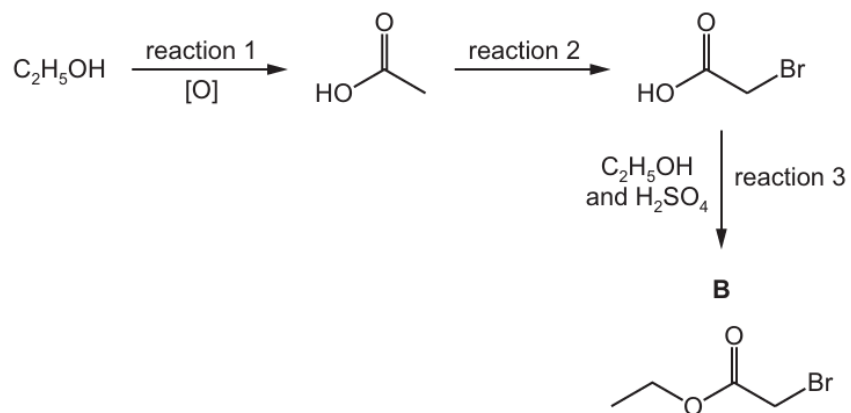
(ii) Name the type of reaction that occurs in step 1.

..... [1]

- 11 Compound **B** is a liquid with a fruity smell.



The reaction scheme shows how **B** can be made from ethanol, C_2H_5OH .



- (a) (i) Reaction 1 is an oxidation reaction.

Give the reagent(s) and conditions required for reaction 1.

reagent(s)

conditions

[2]

- (ii) Construct an equation to represent reaction 1.

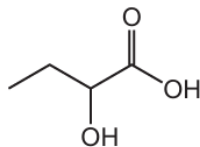
Use [O] to represent an oxygen atom from the oxidising agent in this reaction.

..... [1]

- 12** The reducing agent LiAlH_4 can be synthesised by reacting aluminium chloride with lithium hydride, LiH .

(c) Two students try to prepare 2-hydroxybutanoic acid in the laboratory.

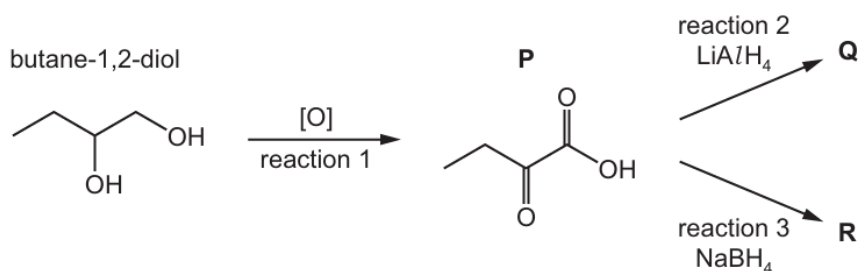
2-hydroxybutanoic acid



Both students oxidise butane-1,2-diol to form **P** in reaction 1.

One student then reduces **P** using LiAlH_4 . **Q** is formed.

The other student reduces **P** using NaBH_4 . **R** is formed.



- (i) State the reagents and conditions required for reaction 1.

.....
 [2]

- (ii) Only one of the students successfully prepares 2-hydroxybutanoic acid.

Identify which of **Q** or **R** is 2-hydroxybutanoic acid and explain the difference between reactions 2 and 3.

.....

 [2]

13 Iodine is used in many inorganic and organic reactions.

(b) Iodoalkanes contain carbon-iodine bonds.

The simplest iodoalkane is CH_3I .

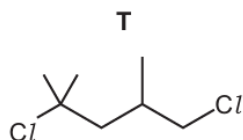
(i) CH_3I can be made from methanol, CH_3OH .

Identify a reagent that can convert CH_3OH to CH_3I .

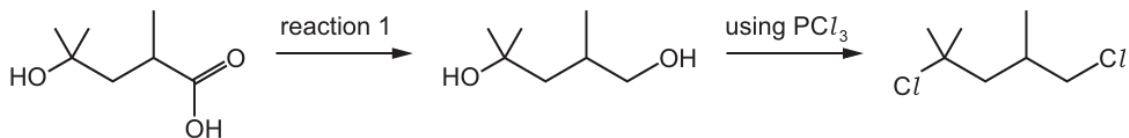
..... [1]

14 PCl_5 , PCl_3 and NCl_3 are halides of Group 15 elements.

(c) PCl_3 is used to convert alcohols to chloroalkanes, such as compound **T**.



A possible synthesis of **T** is shown.

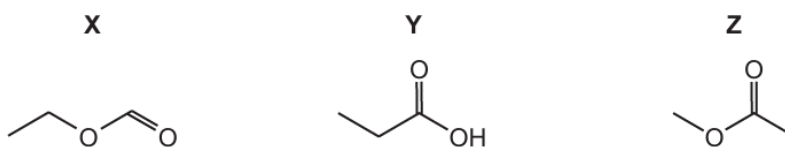


(i) Identify a reagent that could be used in reaction 1.

..... [1]

15 Many naturally occurring esters are used as flavourings in food.

(c) Compounds **X**, **Y** and **Z** are shown. They all have the same molecular formula.



(ii) In three experiments, sodium is added to separate samples of **X**, **Y** and **Z**.

Complete the table to show the observations for each of these three experiments. Ignore any temperature changes which may occur.

experiment	observations
Na + X	
Na + Y	
Na + Z	

[2]