Cambridge AS & A Level

CHEMISTRY

Paper 2

Topical Past Paper Questions

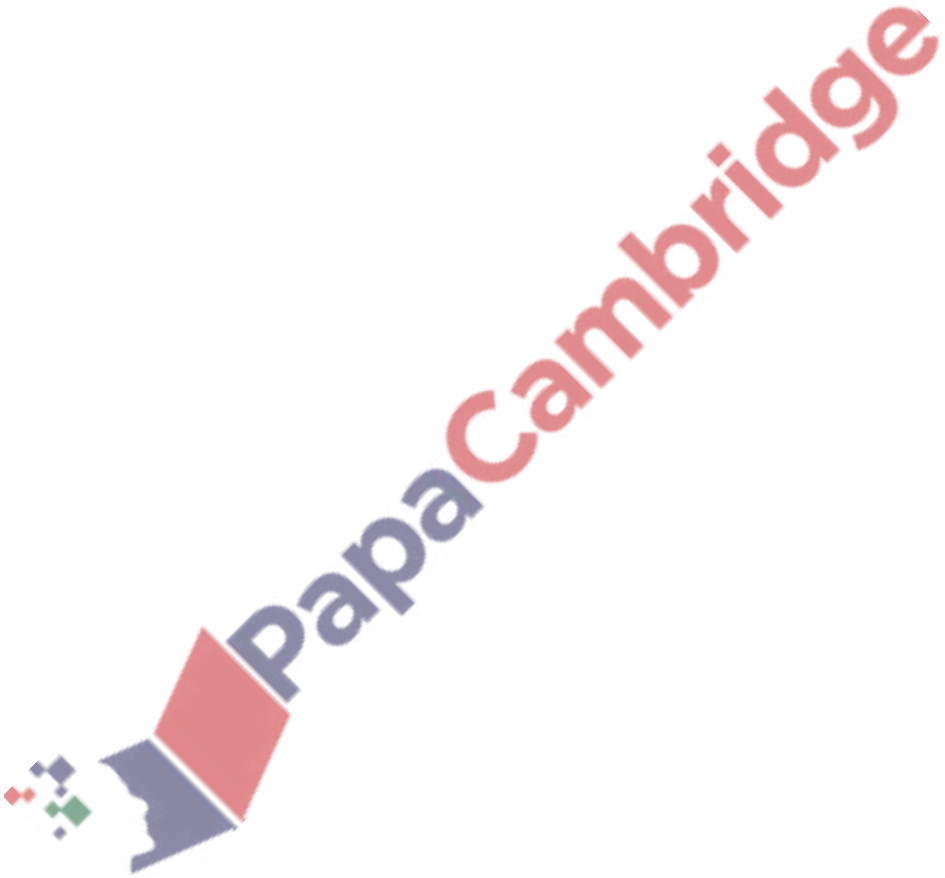
+ Answer Scheme

2015 - 2021

PapaCambridge

Chapter 16

Hydroxy compounds

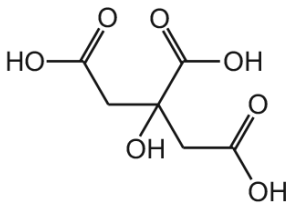


16.1 Alcohols

129. 9701_s21_qp_23 Q: 5

Compound **X** contains the same functional groups as citric acid.

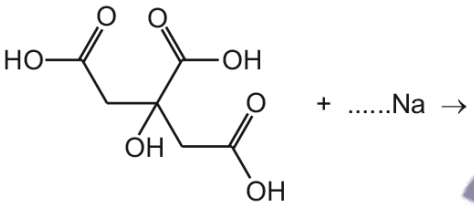
citric acid



The table describes some of the similarities and differences between citric acid and compound **X**.

	citric acid	**X**
chiral centre	no	yes
reaction with Na	fizzing	fizzing
reaction with $H^+/Cr_2O_7^{2-}$	remains orange	orange to green

(a) Complete the equation to show the reaction of excess sodium with citric acid. Show the skeletal structure of the product.



[3]

(b) (i) Use the information in the table to deduce the skeletal formula of **X**, $C_3H_6O_3$. Draw the skeletal formula of **X** in the box. Label the chiral centre of compound **X** with an asterisk (*).

[2]

(ii) Explain why compound **X** reacts with acidified $Cr_2O_7^{2-}$ but citric acid does not.

.....

.....

..... [2]

(c) Compound **X** is one of a pair of stereoisomers.

Stereoisomerism occurs when a molecule has at least one of two key features.

State the two key features that give rise to stereoisomerism.

1 .....

.....

2 .....

.....

[2]

(d) A structural isomer of compound **X** does not fizz when added to sodium.

Explain what is meant by *structural isomer*.

.....

..... [1]

[Total: 10]

130. 9701_w19_qp_22 Q: 3

A series of reactions for phosphorus and its compounds is shown.

$$P \xrightarrow[\text{reaction 1}]{\text{excess } Cl_2} PCl_5 \xrightarrow[\text{reaction 2}]{H_2O} H_3PO_4 \xrightarrow[\text{reaction 3}]{NH_3} (NH_4^+)(H_2PO_4^-)$$

(a) (i) State what you would observe in reaction **1**.

.....

..... [1]

(ii) State the type of reaction that occurs in reaction **2**.

..... [1]

(iii) H_3PO_4 can be produced by direct reaction of phosphorus with nitric acid.

$$P + 5HNO_3 \rightarrow H_2O + 5NO_2 + H_3PO_4$$

Use oxidation numbers to show that this reaction is a redox reaction.

.....

.....

..... [2]

(b) Reaction **3** is a neutralisation reaction in which NH_3 acts as a base.

(i) Explain how NH_3 acts as a base in reaction **3**.

.....

..... [1]

(ii) Draw the three-dimensional shape of the ammonium ion, NH_4^+. Give the bond angle.

bond angle = ... ° [1]

(iii) State the industrial importance of compounds such as $(NH_4^+)(H_2PO_4^-)$.

..... [1]

(c) PCl_5 can be used to convert alcohols to halogenoalkanes.

(i) Write an equation for the reaction of C_2H_5OH with PCl_5 to form C_2H_5Cl.

..... [1]

(ii) State the type of reaction in **(i)**.

..... [1]

(iii) Halogenoalkanes can also be prepared by reacting alcohols with hydrogen halides, such as HCl and HI.

- HCl is prepared using NaCl and concentrated H_2SO_4.
- HI is prepared by reacting NaI with concentrated H_3PO_4.

Suggest why HI is **not** prepared by the reaction of NaI with concentrated H_2SO_4.

.....

.....

..... [2]

(iv) The rate of the hydrolysis reaction of halogenoalkanes with NaOH(aq) is dependent on the halogen that is bonded to carbon.

State and explain the order of reactivity when NaOH(aq) reacts separately with C_2H_5Cl, C_2H_5Br and C_2H_5I.

.....

.....

..... [2]

[Total: 13]

131. 9701_s18_qp_21 Q: 4

X is $CH_3CH(OH)CH_2CH_3$.

(a) The reaction between **X** and alkaline aqueous iodine produces a yellow precipitate.

(i) Give the name of the compound formed as a yellow precipitate in this reaction.

..... [1]

(ii) Give the name of **X**.

..... [1]

(b) There are three structural isomers of **X** that are alcohols.

Draw the structures of these three isomers of **X**.

[2]

(c) Two reactions of **X** are shown.

$CH_3CH(OH)CH_2CH_3$ (**X**) —reaction **1**→ $CH_3COCH_2CH_3$

X —reaction **2**→ C_4H_8

(i) Identify the type of reaction involved in reaction **1**.

..... [1]

(ii) Identify the reagents for reaction **1**.

..... [1]

(iii) Reaction **2** can be carried out by passing the vapour of **X** over hot aluminium oxide.

The product of reaction **2**, C_4H_8, is actually a mixture of three isomers.

Give the full names of the three isomers formed by reaction **2**.

1 .....

2 .....

3 .....

[3]

(d) The reaction of methylpropene, $(CH_3)_2CCH_2$, with hydrogen bromide, HBr, produces a mixture of two halogenoalkanes.

One of the halogenoalkanes, 2-bromo-2-methylpropane, is formed as the major product while 1-bromo-2-methylpropane is formed in small quantities.

(i) Complete the mechanism to show the reaction of methylpropene with HBr to form the **major** product.

Include the structure of the intermediate and all necessary charges, dipoles, lone pairs and curly arrows. The structure of 2-bromo-2-methylpropane is not required.

[4]

(ii) Explain why 2-bromo-2-methylpropane is the major product of this reaction.

.....

.....

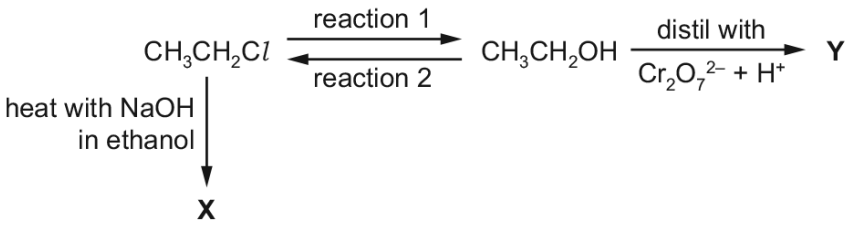
.....

..... [2]

[Total: 15]

132. 9701_w15_qp_21 Q: 4

Some reactions involving ethanol are shown.



(a) (i) Give an equation for reaction 2 including the reagent needed for the conversion.

..... [2]

(ii) State the reagent and conditions required for reaction 1.

..... [2]

(b) (i) Identify the organic product **X**.

..... [1]

(ii) Nitric acid is added to the products of reaction of CH_3CH_2Cl with NaOH in ethanol. Silver nitrate solution is then added to this mixture.

State what you would observe.

..... [1]

(iii) Write an ionic equation, including state symbols, for the reaction responsible for the observation in **(ii)**.

..... [1]

(c) (i) Identify the organic product **Y** which is distilled out of the reaction mixture.

..... [1]

(ii) Explain, in terms of the properties of and intermolecular forces in CH_3CH_2OH and **Y**, why the chosen conditions for the reaction ensure that **Y** is the product.

.....

.....

..... [3]

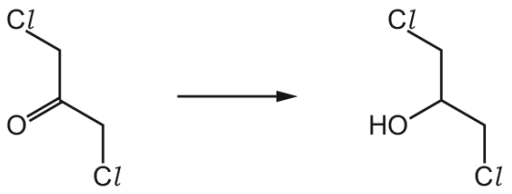
[Total: 11]

16.2 Phenol

133. 9701_s21_qp_23 Q: 4

(a) 1,3-dichloropropan-2-ol can be made by reacting **M**.

M 1,3-dichloropropan-2-ol



(i) Give the systematic name of **M**.

..... [1]

(ii) Name the functional group present in **M** that changes during this reaction.

..... [1]

(iii) State a suitable reagent for this reaction.

..... [1]

(b) Separate samples of 1,3-dichloropropan-2-ol and 3-chloropropane-1,2-diol are heated with excess acidified $Cr_2O_7^{2-}$ until there is no further reaction.

In each reaction, a different organic product, **Q** or **R**, is made.

1,3-dichloropropan-2-ol 3-chloropropane-1,2-diol

Q and **R** are tested separately with 2,4-dinitrophenylhydrazine solution, 2,4-DNPH, and sodium carbonate solution, $Na_2CO_3(aq)$.

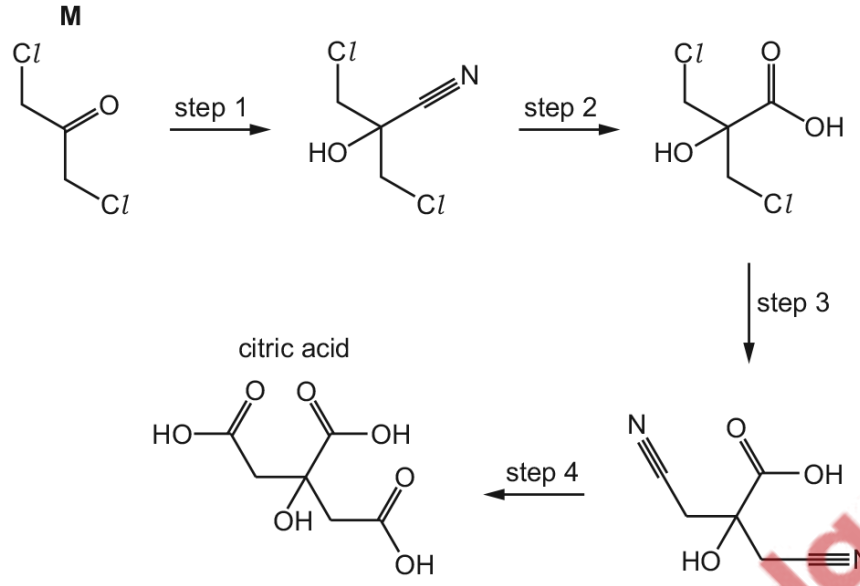
Complete the table to give any relevant observations.

If no reaction occurs, write 'no visible change'.

reagent	observation with **Q**	observation with **R**
2,4-DNPH		
$Na_2CO_3(aq)$		

[4]

(c) Citric acid can be made from **M** in a four-step reaction.



Complete the table for each step of the reaction sequence to identify:

- the reagents and conditions required
- the type of reaction.

step	reagent and conditions	type of reaction
1		
2	dilute sulfuric acid	
3		
4	dilute sulfuric acid	

[5]

[Total: 12]