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Level 2 Chemistry, 2015

91165 Demonstrate understanding of the properties of selected organic compounds

9.30 a.m. Monday 23 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the properties of selected organic compounds.	Demonstrate in-depth understanding of the properties of selected organic compounds.	Demonstrate comprehensive understanding of the properties of selected organic compounds.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table is provided on the Resource Sheet L2–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 20

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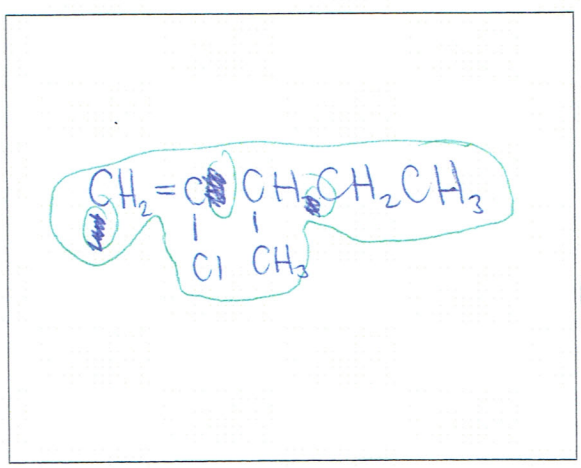
QUESTION ONE

(a) (i) Complete the following table to show the structural formula and IUPAC (systematic) name for each compound.

Structural formula	IUPAC (systematic) name
$CH_2CH_2CH_3$ NH_2	propan-1-amine
CH_3CHCH_2COOH Cl	2-chlorobutanoic acid
$CH_3-CH_2-CH_2-CH(CH_3)-CH(OH)-CH_3$	3-methyl hexan-2-ol
$CH_3-C(Br)(CH_3)-CH_3$	2-bromo-2-methylpropane

(ii) The organic compound, 4-chloro-3-methylpent-4-ene has been named incorrectly.

Draw the implied structure and explain why it is named incorrectly.



It should be 2-chloro-3-methylpent-1-ene. This is because the functional group -Cl is dominated by the double C=C - functional group for alkenes and thus not as important so it is counted last.

The correct IUPAC name for this structure is:

haloalkene

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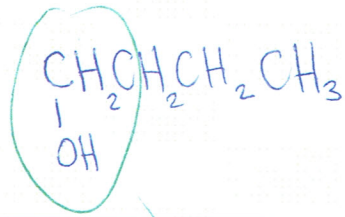
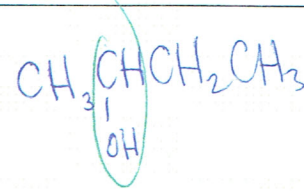
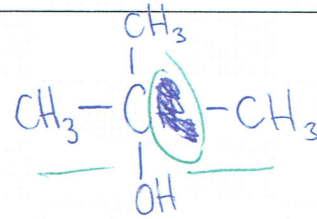
(b) Butan-1-ol has the molecular formula $C_4H_{10}O$. Its structural formula is:

$$CH_3 - CH_2 - CH_2 - CH_2 - OH$$

(i) Define the term constitutional (structural) isomer.

Constitutional isomers have the same molecular formula with the same number of each different element to each other but they have different structures

(ii) Draw THREE other constitutional (structural) isomers of $C_4H_{10}O$.

Alcohol	Structural formula
A	
B	
C	

(iii) Choose a **secondary** alcohol from the structures above and give a reason for your choice.

Letter: A **B** C (circle your choice)

Reason:

This is because the -OH group is attached to a carbon atom that is bonded to two other carbon atoms

(c) Four separate colourless organic liquids are known to be:

- ethanol – $Cr_2O_7^{2-}/H^+$
- ethanoic acid – $Na_2CO_3(aq)$
- hex-2-ene – bromine water
- hexan-1-amine (1-aminohexane). – remaining

Write a procedure to identify each of these organic liquids using **only** the reagents listed below.

- acidified dichromate solution, $Cr_2O_7^{2-}/H^+(aq)$
- bromine water, $Br_2(aq)$
- sodium carbonate solution, $Na_2CO_3(aq)$.

In your answer, you should:

- identify the test reagents used
- describe any observations that would be made
- identify the type of reaction that occurs
- identify the organic product of any reaction.

You do not need to include equations in your answer.

Take a sample from each liquid. Add a few drops of bromine water into each sample. Only hex-2-ene will reacts with bromine water. This is because an addition reaction occurs where the C=C double bond is broken and in the openings, two bromine atoms are added into the newly available positions, forming two new bonds and an alkane. This therefore forms the product, 2,3-dibromohexane and the orange-brown bromine water rapidly decolourises, in a short period of time.

$CH_3CH=CHCH_2CH_2CH_3 + Br_2(aq) \Rightarrow CH_3CHBrCHBrCH_2CH_2CH_3$

The remaining three liquids do not change the colour of bromine water. (do not react with $Br_2(aq)$ and thus cause any change in colour)

Add sodium carbonate into the remaining samples.

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Only ethanoic acid will react with Na_2CO_3 (aq). This is because a neutralisation reaction occurs which causes the fizzing of Na_2CO_3 and causes a colourless gas (carbon dioxide) to bubble off. This therefore forms the products CH_3COONa, carbon dioxide and water.

$$2CH_3COOH + Na_2CO_3(aq) \longrightarrow 2CH_3COONa + CO_2 + H_2O$$

The remaining two liquids do not react with sodium carbonate.

Add a few drops of acidified dichromate solution into the remaining two samples. Only ethanol will react with the acidified dichromate. This is because an oxidation-reduction reaction occurs where ethanol is oxidised to form the carboxylic acid, ethanoic acid (and the orange $Cr_2O_7^{2-}$ will be reduced to green Cr^{3+}, which causes the orange solution to turn green)

$$CH_3CH_2OH \xrightarrow{Cr_2O_7^{2-}/H^+} CH_3COOH$$

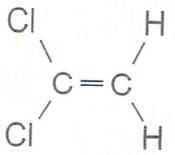
The remaining liquid that doesn't react with the acidified dichromate solution is 1-aminohexane.

E7

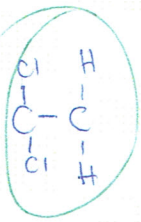
QUESTION TWO

Cling Wrap is a polymer that can be made from the monomer 1,1-dichloroethene.

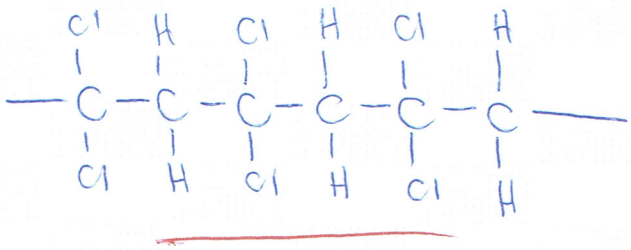
http://savingcentswithcoupons.com/money-maker-deal-on-glad-cling-wrap-at-shoprite/



1,1-dichloroethene



(a) (i) In the box below, draw THREE repeating units of the polymer formed.

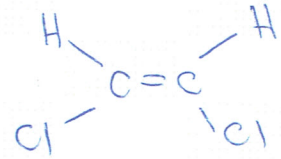
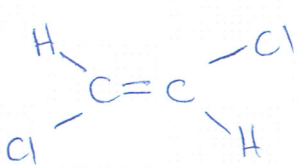


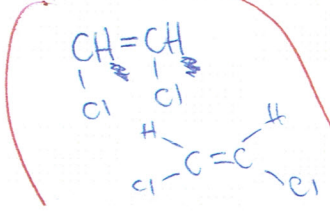
(ii) Explain why 1,1-dichloroethene cannot exist as a *cis-trans* isomer.

1,1-dichloroethene cannot exist as a cis-trans isomer as it does not meet the requirements. Although it has a double bond that restricts rotation about the C=C bond, it does not have different groups attached to the end of each carbon atom instead in the double bond - in this case two hydrogen atoms on one carbon atom and two chlorine atoms on the other. This therefore means that 1,1-dichloroethene cannot give rise to geometric isomers.

(iii) A structural isomer of 1,1-dichloroethene **can** exist as *cis-trans* isomers.

Draw and name the *cis-trans* isomers.

Structure		
Name	cis-1,2-dichloro eth-1-ene	trans-1,2-dichloro eth-1-ene



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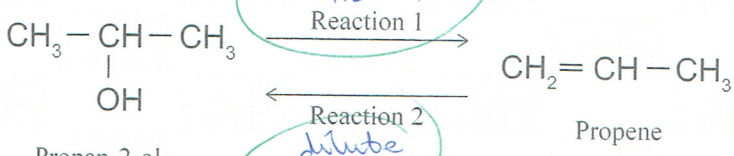
(b)



Propan-2-ol

Propene

In Reaction 1, propan-2-ol can be converted to propene.

In Reaction 2, propene can be converted back to propan-2-ol.

Analyse BOTH of these reactions by:

- describing the reagents and conditions needed for each reaction to occur
- identifying each type of reaction and explaining your choice
- explaining why Reaction 1 forms only a single organic product, but Reaction 2 forms a mixture of organic products.

With concentrated H_2SO_4 in reaction one, an elimination reaction occurs where the -OH group along with a hydrogen atom is removed. This forms the product propene along with the new C=C bond. Propan-2-ol (propan-2-ol reacts with concentrated H_2SO_4 and reaction) only forms a single organic product as propan-2-ol is symmetrical and thus there is only one choice in which the hydrogen atom can be removed.

In reaction 2, with dilute H_2SO_4, an addition reaction occurs where propene reacts with $H_2O/H^+(aq)$ and the double C=C bond is broken. In these openings, a hydrogen atom and a -OH group is added into the newly available positions, forming two new bonds. When the double bond is broken, there are two choices for which the hydrogen atom can be added in as propene is asymmetrical.

$CH_2=CHCH_3 \xrightarrow{\text{dilute } H_2SO_4} CH_3CH(OH)CH_3 + CH_2(OH)CH_2CH_3$

(propan-2-ol: major; propan-1-ol: minor)

A major product arises when the hydrogen atom is added to the carbon atom (carbon atom 1) that already has the greatest number of hydrogen atoms (carbon atom 1 already has 2 hydrogen atoms attached whereas carbon atom 2 already has 1 hydrogen atom attached). This thus the -OH group is added to carbon atom 2 - This therefore forms the major product, propan-2-ol.

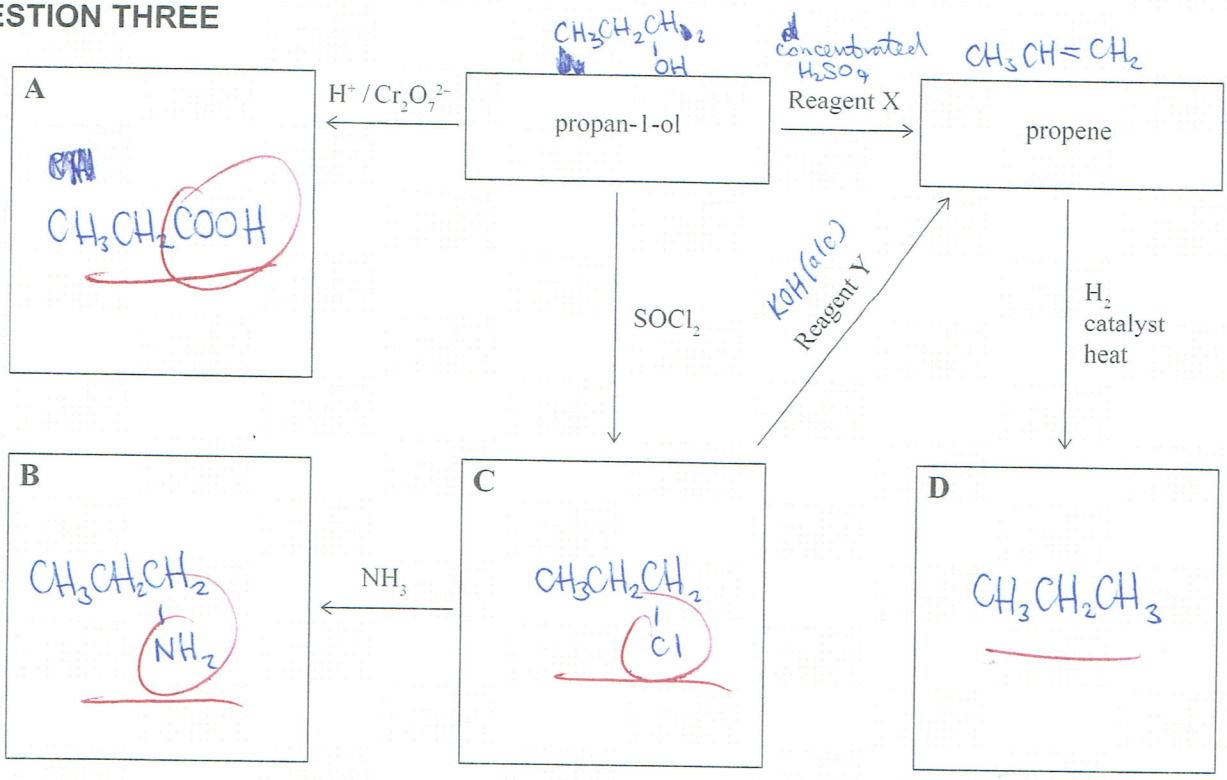
11 E5

Continue on esters paper

See

QUESTION THREE

(a)



(i) Complete the scheme above by drawing the structural formulae of the organic compounds A to D.

(ii) Circle the functional group of each of the organic compounds A, B, and C that you have drawn.

(iii) Identify reagents X and Y.

Reagent X: concentrated H_2SO_4

Reagent Y: KOH(alc)

(b) Ethene, $C_2H_4(g)$, reacts with aqueous potassium permanganate solution, $KMnO_4(aq)$, dilute acid, H_2O/H^+, and hydrogen bromide, HBr.

$CH_2=CH_2$ – $KMnO_4$ – H_2O/H^+ – HBr

Compare and contrast the reactions of ethene gas with each of these three reagents.

In your answer, you should:

- describe any observations that can be made
- identify, with reasons, the type of reaction ethene undergoes with each reagent
- describe the functional group of the products formed
- include equations showing the structural formulae for the organic compounds for each reaction.

With potassium permanganate solution, $KMnO_4(aq)$, an oxidation reaction occurs where the double C=C bond in ethene occurs, and in the openings

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of the double C=C bond, two hydroxide, −OH groups are added into the newly available positions, forming two new bonds. This forms the diol, ethan-1,2-diol (and the purple MnO_4^- is reduced to colourless Mn^{3+} causing the purple solution to becomes colourless)

$$CH_2{=}CH_2 \xrightarrow{MnO_4^-/H^+} CH_2(OH)CH_2(OH)$$

With $H_2O/H^+(aq)$, an addition reaction occurs when ethene reacts with dilute H_2SO_4 and the double C=C bond is broken. In these openings, a hydrogen atom and a −OH group are added into the newly available positions, forming two new bonds. This forms the primary alcohol, ethan-1-ol

$$CH_2{=}CH_2 \xrightarrow{H_2O/H^+(aq)} CH_2(OH)CH_3$$

With HBr, an addition reaction occurs when ethene reacts with HBr and the breaking of the double C=C bond occurs. In the newly available openings are added with a hydrogen atom and a bromine atom, forming two new bonds. This forms the haloalkane, 1-bromoethane.

$$CH_2{=}CH_2 + HBr \longrightarrow CH_3CH_2Br$$

M5

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

ASSESSO USE ON

Question 2 (b)

The minor product arises when the hydrogen atom is added onto carbon atom 2 and thus the ~~[illegible]~~ -OH group is added onto carbon atom 1. This therefore forms the minor product, propan-1-ol.