2

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91165

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QUALIFY FOR THE FUTURE WORLD
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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.

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Low Merit

TOTAL 16

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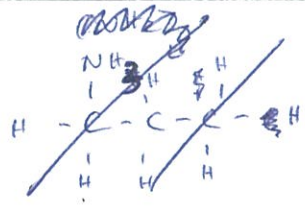
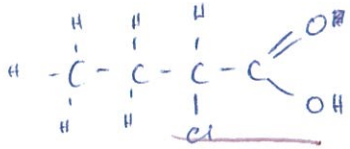
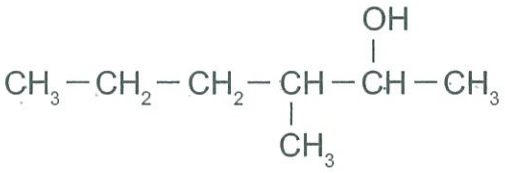
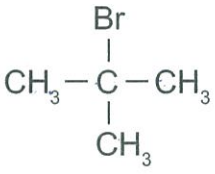
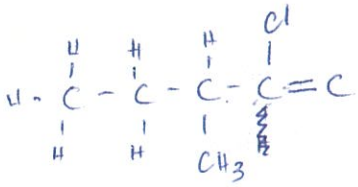
QUESTION ONE

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

Structural formula	IUPAC (systematic) name
	propan-1-amine
	2-chlorobutanoic acid
	3 - methylhexan - 2 - ol
	2 - bromo - 2 ~~methyl~~ - methylpropane ~~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.



You name from the lowest number to the first functional group. ~~group~~ group, not just from left to right

The correct IUPAC name for this structure is:

2-chloro-3-methylpent-1-ene

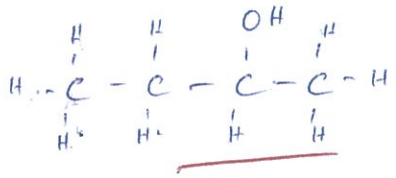
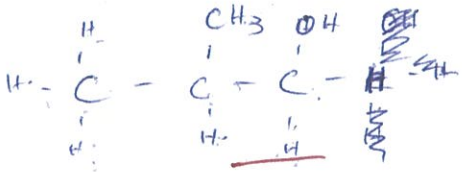
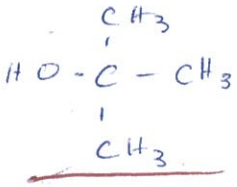
(b) Butan-1-ol has the molecular formula $C_4H_{10}O$. Its structural formula is:

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

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

a constitutional isomer has the same molecular formula but different structural formula

(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:

the -OH group is attached to a carbon atom that is attached to two other carbons

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4

4

1

4

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

- ethanol
- ethanoic acid
- hex-2-ene
- hexan-1-amine (1-aminohexane). - smells funny.

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

→ diol with ethanol
↳ (oxidised)

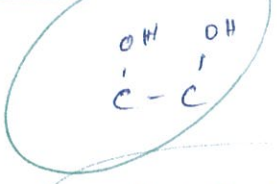
- acidified dichromate solution, $Cr_2O_7^{2-}/H^+(aq)$
- bromine water, $Br_2(aq)$ - hex-2-ene - addition.
- sodium carbonate solution, $Na_2CO_3(aq)$.

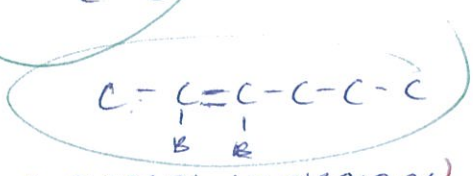
↳ acid base ethanoic.

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.

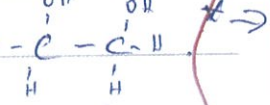
You do not need to include equations in your answer.





1. Smell all liquids - the one with a pungent, unpleasant and mildly fishy smell will be 1-aminohexane.

~~Y colour~~

Test the remaining 3 liquids with the $Cr_2O_7^{2-}/H^+(aq)$. The ethanoic acid and $Cr_2O_7^{2-}/H^+(aq)$ will undergo an oxidation reaction, forming a diol,  . Hex-2-ene and ~~the~~ ethanoic acid will not react and will remain green. Now test the two remaining liquids (new solutions) with bromine water. Hex-2-ene will undergo a rapid addition reaction, with the orange $Br_2(aq)$ and colourless hex-2-ene rapidly changing back to colourless. The product will be 2,3-dibromohexane. ~~The~~ with the remaining solution, add the $Na_2CO_3(aq)$. This should produce an acid base reaction, forming a metal salt, carbon dioxide and water. gas given off bubbles should be seen and Na_2CO_3 should disappear.

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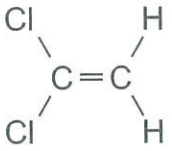
colour changes from green to orange as the $Cr_2O_7^{2-}/H^+(aq)$ is reduced.

A4

QUESTION TWO

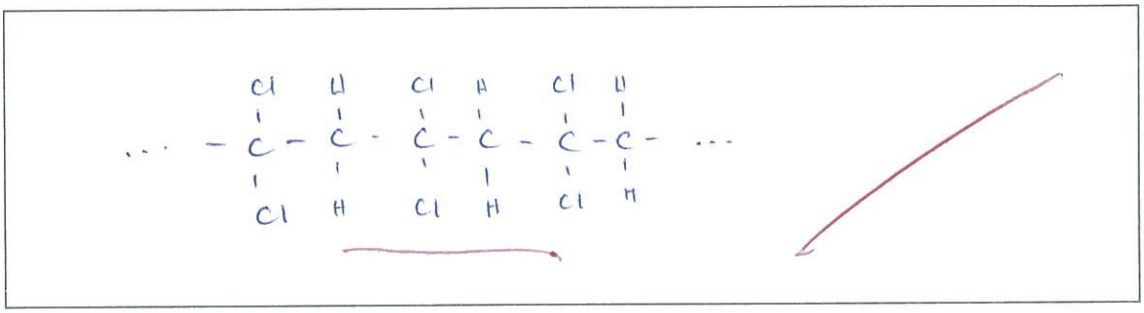
Cling Wrap is a polymer that can be made from the monomer 1,1-dichloroethene.

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.



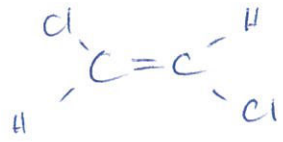
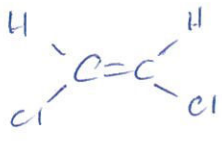
(ii) Explain why 1,1-dichloroethene cannot exist as a *cis-trans* isomer.

for a cis/trans isomer to occur, there must be a double bond (or ring) which restricts rotation and also two different groups of atoms or atoms attached to either side of the double bond. 1,1-dichloroethene does not fit this, having 2 groups of the same atoms on either side of the double bond.

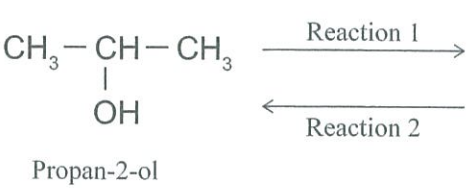
meaning position of the atoms is fixed.

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

Draw and name the *cis-trans* isomers.

Structure		
Name	transdichloroethene	cisdichloroethene.

(b)



elimination ~~HCl~~ H_2SO_4

addition H_2O/H^+

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

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

$CH_2 - CH_2 - CH_3$
OH

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.

Reaction one is an elimination reaction, where the propan-2-ol is dehydrated or eliminated using concentrated sulfuric acid to form propene. This is an elimination reaction because single bonds have been broken and -OH group and H taken off and a double bond replacing them. There is only one product because on either side of the C the -OH is joined to, the C's both have 3 hydrogen atoms attached, so ~~the~~ it doesn't matter if the double bond is to the right or left ~~and~~ by the ~~shape~~ IUPAC name would be the same. Reaction 2 is an addition reaction involving H_2O/H^+, ~~where the~~ It is an addition reaction because the double bond in propene is broken and an -OH and H group have been added. There are major and minor products available from this reaction which can be figured out using the rule 'rich get richer'. Propan-2-ol is the major product as it had the most H's attached before the bond was broken and gained another H. got richer. Propan-1-ol would be the minor product. Reaction 2 forms two products because there are two structurally different possibilities that can occur ~~of~~ as a product of the reaction.

E7

QUESTION THREE

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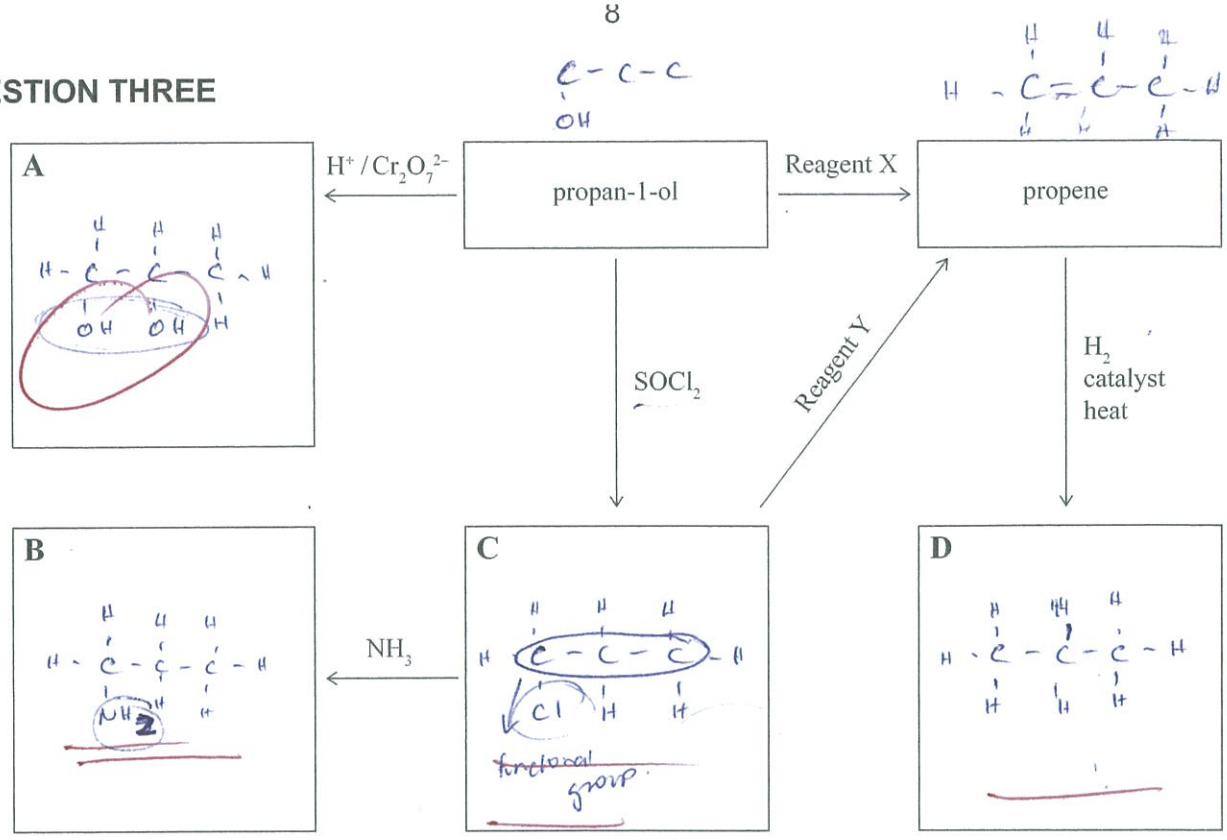
(a)



(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: alcoholic KOH.

oxidise - alcohol
purple - brown

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

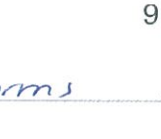
Compare and contrast the reactions of ethene gas with each of these three reagents.

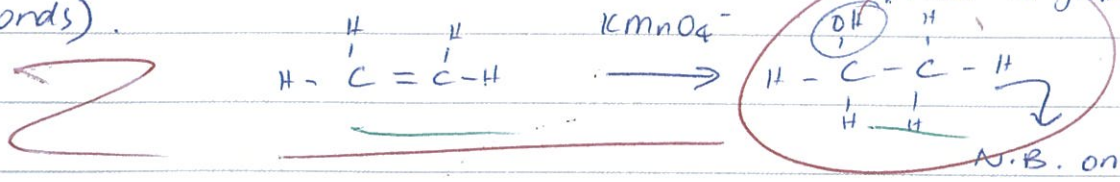
In your answer, you should:

- 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.

When ethene and $KMnO_4(aq)$ react, ethene undergoes an oxidation reaction, meaning the purple solution changes to a brown solution as the MnO_4^{2-} is

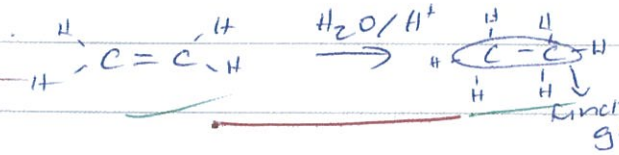
ASSESSOR'S USE ONLY

reduced. The Ethene forms  This is an addition reaction as the double bond in ethene has been broken and a -OH and -H group put in (2 single bonds).



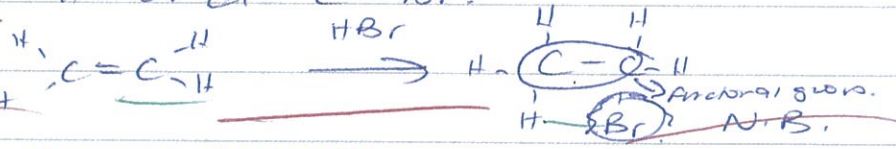
N.B. only one product available as adding -OH / -H to either C would result in same structure.

Ethene will react with H_2O/H^+ to form an alkane.



This is also an addition reaction as the double bond in ethene has been broken and 2 new single bonds with -H groups added. H_2O/H^+ is colourless, as is ethane, so ~~no colour~~ obvious observations would be made.

When ethene reacts with HBr it undergoes an addition reaction also, ~~however~~ as it is also breaking the double bond and replacing it with two single bonds C-H and C-Br.



This would form a halogenalkane, ~~and~~ no obvious observations would occur as HBr is colourless colour change would be from colourless to colourless, so no obvious change.

All three reactions are addition reactions, however only with H_2O/H^+ and HBr are the functional groups (alkanes are same. With the $KMnO_4^-$ the functional group is an alcohol.

Like with $KMnO_4^-$, they are only one possible product and the molecule has only 2 carbons so adding the -H or -Br to either would result in the same molecule, only flipped.

M5

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Level 2 Chemistry, 2015

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High Merit

TOTAL 17

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

- ethanol – $Cr_2O_7^{2-}/H^+(aq)$ orange → green
- ethanoic acid
- hex-2-ene
- hexan-1-amine (1-aminohexane).

CH_3COOH

$CH_3CH_2CH_2CH_2$

Na_2CO_3

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, $Na_2CO_3(aq)$.

$CO_2 + H_2O$

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.

First add the orange $Br_2(aq)$ water to all solutions. This will distinguish the hex-2-ene, as the alkene will be the only one to react with the orange Bromine water ($Br_2(aq)$) through a substitution reaction to form colourless $CH_3CHBrCHBrCH_2CH_3$. This does not require UV light or heat and is a fast reaction which occurs immediately. The product formed is a haloalkane bearing 2 Br functional groups.

Next add the acidified dichromate solution $Cr_2O_7^{2-}/H^+(aq)$ and heat to all other solutions. This will distinguish ethanol, the alcohol as it will be the only one which reacts with the acidified dichromate with heat to form the carboxylic acid – ethanoic acid bearing the COOH functional group. The ethanol will go from the orange to green and it is

an elimination reaction, forming $H_{2(g)}$ also.
Next add the Sodium Carbonate solution ($Na_2(CO_3)$) to the remaining 2 solutions. This distinguishes the Carboxylic acid CH_3COOH, which will go through the acid + carbonate → salt + water + Carbondioxide reaction. Upon the formation of the Carbon dioxide ($CO_{2(g)}$) gas fizzing will be bubbles will be produced observed and as $CO_{2(g)}$ is produced. That leaves the amine which is the last solution. //

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QUESTION TWO

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

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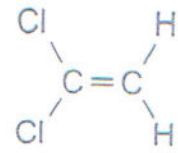
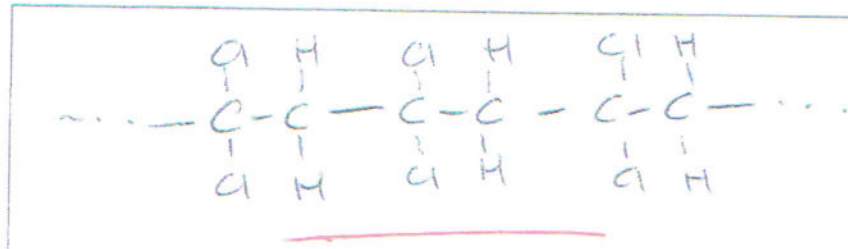


1,1-dichloroethene

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

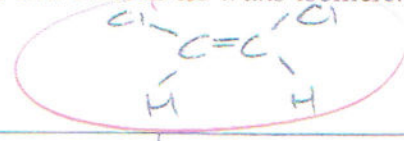


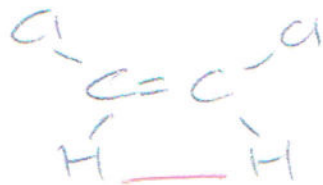
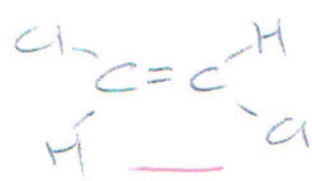
(ii) Explain why 1,1-dichloroethene cannot exist as a *cis-trans* isomer.

Because geometric isomers can only exist when ~~the~~ atoms or group of atoms are on ~~the~~ ~~opposite~~ each ~~C~~ Carbon participating bond ~~bro~~ in the double.

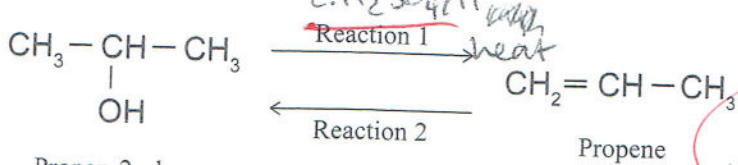
(iii) A structural isomer of 1,1-dichloroethene **can** exist as *cis-trans* isomers.

Draw and name the *cis-trans* isomers.



Structure		
Name	cis-1,2-dichloroethene	trans-1,2-dichloroethene

(b)



ASSESSOR'S USE ONLY

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.

Reaction 1 elimination/dehydration reaction. It needs concentrated H_2SO_4 / H^+ and heat to occur. The conc. H_2SO_4 / H^+ is the dehydrating agent and removes an OH and H from 2 Carbon atoms to form H_2O and propene from propan-2-ol.

Reaction 2 This is an addition reaction. The C=C double bond breaks and one Carbon accepts the -OH group and the other Carbon the H Hydrogen atom. They react with H_2O / H^+ and heat for this to occur. This reaction can form 2 organic products, a major product (most of the products form this) and a minor product. Following Markovnikov's rule "the rich get richer" so the Carbon atom bearing the most H atoms will get the H atom from the reaction and the other Carbon participating in the double bond the OH group. This is the major product. The minor product is when the Carbon bearing the most H atoms gets the OH group instead and the other C atom from the double bond gets the H atom.

See extra paper

Seen

MG

QUESTION THREE

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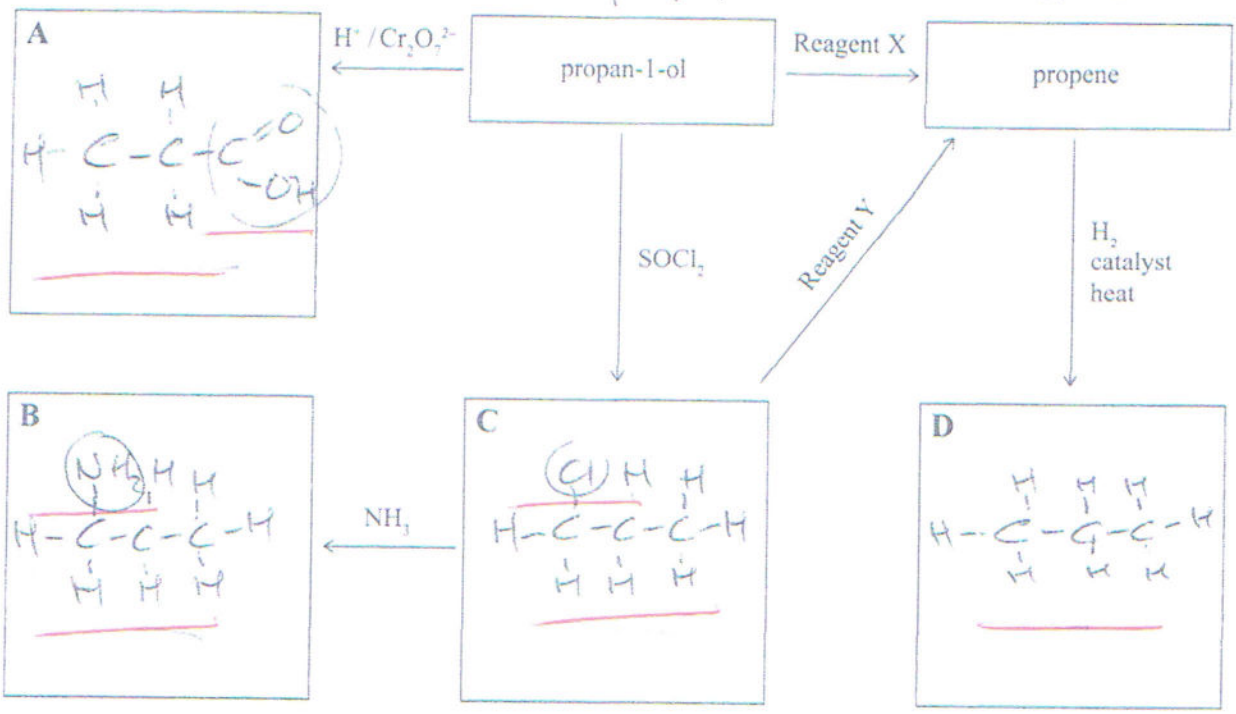
(a)



(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: conc. H_2SO_4 / H^+ heat

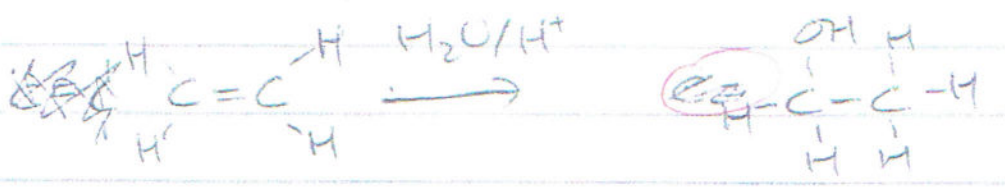
Reagent Y:

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

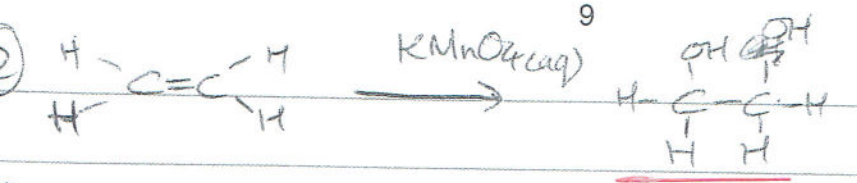
Compare and contrast the reactions of ethene gas with each of these three reagents.

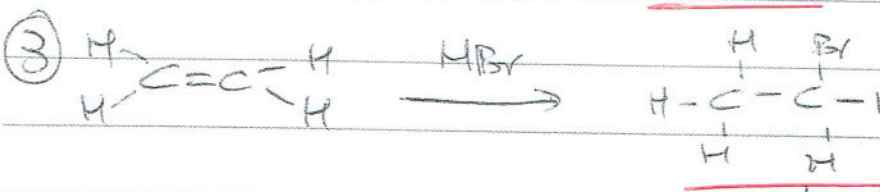
In your answer, you should:

- 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.



ASSESSOR'S USE ONLY

(2) 

(3) 

originally into/with the double bond.

(1) The addition of ~~three~~ ethene with H_2O/H^+ * results in the ~~breaking of the double bond and the~~ addition of an -OH and H atom to the 2 C atoms ~~There~~ the reactant Solution remains colourless. This is an addition reaction as ~~p~~ groups are added to the original structure. The functional group is an alcohol.

(2) This is an ~~addition~~ oxidation reaction and requires purple $KMnO_{4(aq)}$ reactant is the addition of 2 -OH groups to ~~the~~ the original ethene. Each Carbon atom now gains an OH group and the double bond breaks. The $KMnO_{4(aq)}$ is originally purple in colour ~~but~~ but the reaction will turn the solution very pale pink, really colourless due to presence of (Mn^+ ion). The functional group of the -OH is alcohol.

(3) The ~~addition~~ addition reaction of the H atom from the substance HBr. and Br atom. ~~The first with the molecule Substance HBr this~~ The Carbon ~~bond~~ breaks and ~~transforms~~ has to Carbon (C=C) double the addition of ~~a~~ a hydrogen (H) atom and Br (Bromine) atom. (with the addition of the haloalkane -X group (-Br)). the solution goes from Colourless to orange due to the Br presence ~~ion~~ The functional group is haloalkane. The Br is the functional group.

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

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QUESTION NUMBER

2 b) ~~The~~ Reaction 1 cannot form a major or minor product, only 1 product as Markovnikovs rule applies only with the addition of a -HX group or -OH group whereas this is an elimination reaction only 1 product can form. !!