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Level 2 Chemistry, 2016

91165 Demonstrate understanding of the properties of selected organic compounds

9.30 a.m. Monday 21 November 2016
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 2–12 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 22

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QUESTION ONE

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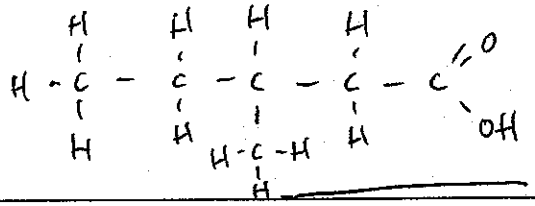
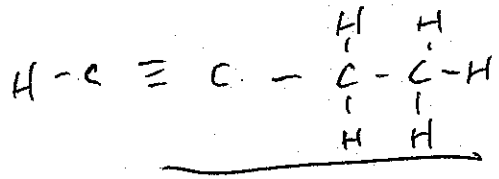
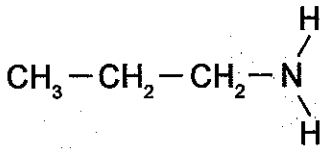
(a) (i) Complete the following table.

Structural formula	IUPAC (systematic) name
$CH_3-CH_2-CH_2-CH_2-\underset{\displaystyle I}{CH}-CH_3$	2-iodohexane
	3-methylpentanoic acid
	but-1-yne
	propan-1-amine

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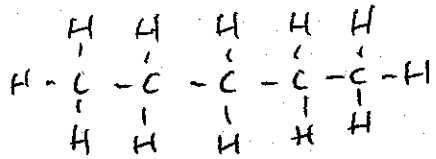
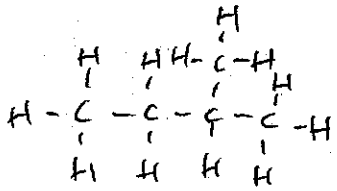
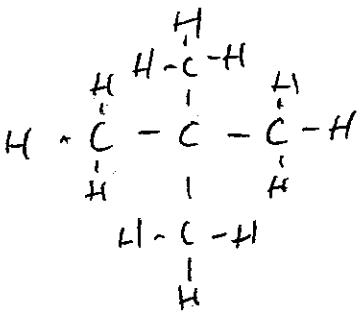
(ii) Draw and name the THREE constitutional (structural) isomers of the organic compound C_5H_{12}.



pentane



2-methylbutane



2,2-dimethylpropane

(b) (i) Classify the following haloalkanes as primary, secondary or tertiary.

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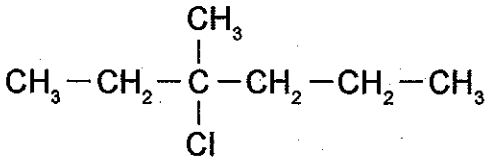
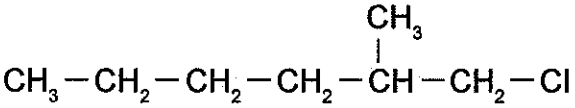
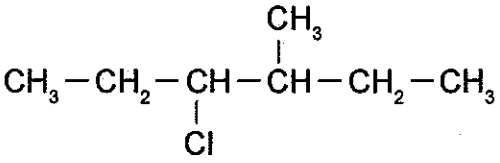
	Haloalkane	Classification
A		tertiary
B		primary
C		secondary

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(ii) Explain your choice for haloalkane **A**.

The halogen atom (Cl) is bonded to a carbon atom that is bonded to three other carbon atoms, therefore making it a tertiary haloalkane.

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(c) Some alkenes are able to form *cis* and *trans* (geometric) isomers.

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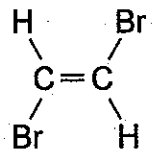
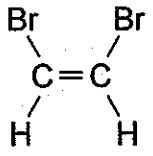
(i) Complete the names of structures **A** and **B** in the table below.

A	**B**
	
trans 1,2-dibromoethene	cis 1,2-dibromoethene

(ii) Elaborate on the structure of the organic compound 1,2-dibromoethene to explain why it is able to form *cis* and *trans* (geometric) isomers.

To form geometric isomers there must be a double bond within the molecule. Also there must be different atoms, or groups of atoms bonded to the C atoms, either side of the double bond. 1,2-dibromoethene can form cis-trans isomers because it contains a double bond. This bond prevents rotation and so the atoms are fixed in space. If it only contained single bonds then rotation could occur and so geometric isomers would not be possible. Also 1,2-dibromoethene has different atoms bonded to each carbon atom. C1 has a hydrogen and bromine atom bonded to it and C2 has a hydrogen and bromine atom bonded to it. Because there are different atoms bonded to each C carbon, geometric isomers are possible. There can be the cis isomer in which the H atoms are on the same side of the double bond, and the Br atoms are on the same side of the double bond, or the trans isomer, in which the H atoms are on opposite sides of the double bond and the Br atoms are on opposite sides of the double bond

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QUESTION TWO

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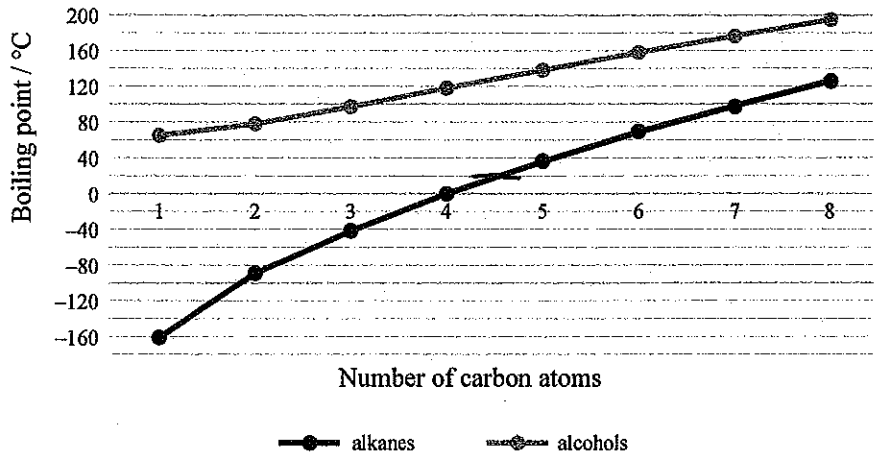
(a) **Boiling points of straight chain alkanes and primary alcohols**



(i) Identify the trends shown on the graph above.

As the carbon chain length increases, so does the boiling points for both alkanes and alcohols. All alcohols have higher boiling points than their corresponding alkanes eg one carbon for alcohols is a boiling point at approx 65°C where as for alkanes the one carbon alkanes is much lower at -160°C

(ii) Identify which alkanes will be gases at room temperature (20°C) according to the graph above.

Alkanes which have carbon chains of 4 atoms or shorter will be gases at room temp. - ie methane, ethane, propane and butane.

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(b) Solutions of amines are described as bases, and solutions of carboxylic acids are described as acids.

(i) Complete the balanced equation for the reaction between solutions of ethanamine, $CH_3CH_2NH_2(aq)$ and hydrochloric acid, $HCl(aq)$.

$CH_3CH_2NH_2(aq) + HCl(aq) \rightarrow$ $CH_3CH_2NH_3^+_{(aq)} + Cl^-_{(aq)}$

(ii) Explain the statement 'carboxylic acids have acidic properties'.

Refer to the reaction between ethanoic acid, $CH_3COOH(aq)$, and water, $H_2O(\ell)$ in your answer.

$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$

Carboxylic acids have acidic properties because when they react with water they donate a proton (H atom) to form H_3O^+ ions. Proton donating is an acid what acids do. Also the formation of lots of H_3O^+ ions indicates an acidic solution. When ethanoic acid (or other carboxylic acids) reacts with water more H_3O^+ ions are formed than OH^- ions. A greater amount of H_3O^+ ions indicates an acid. Also this will cause it to have a pH less than 7, which indicates it is an acid so therefore shows that carboxylic acids have acidic properties.

(c) Ethane gas, $C_2H_6(g)$, and ethene gas, $C_2H_4(g)$, will both react with bromine water, $Br_2(aq)$.

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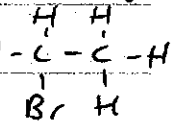
Compare and contrast these two reactions.

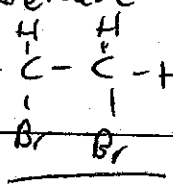
In your answer you should refer to:

- any conditions required
- the observations made
- the types of reactions occurring
- structural formulae of the organic products formed.

When ethane gas reacts with bromine water the conditions are the ~~presence~~ presence of a UV light and/or heat, without a UV light the reaction will occur very slowly, however with a UV light you will be able to see the orange-brown bromine water decolourise into a colourless solution. This is a substitution reaction because a H atom is being replaced by a Br atom to form a haloalkane. The product formed are bromoethane and HBr. The structral formula of bromoethane is:



~~When~~ The reaction of bromine water and ethene gas doesn't require any conditions. The orange-brown bromine water will rapidly decolorise. This is an addition reaction because the double C=C bond is being broken, forming 2 spare bonds which 2 Br atoms bond to. The product is 1,2-dibromoethane which has a structral formula of:



Both reactions involve the ~~Brown~~ ~~Brown~~ orange solution decolorising and a haloalkane formed. However the reaction with ethane gas requires a UV light & undergoes an ~~addition~~ substitution reaction to form bromo ethane and another product where as the reaction with ethene gas has no conditions and undergo a ~~addition~~ addition reaction to form 1,2-dibromoethane.

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E8

QUESTION THREE

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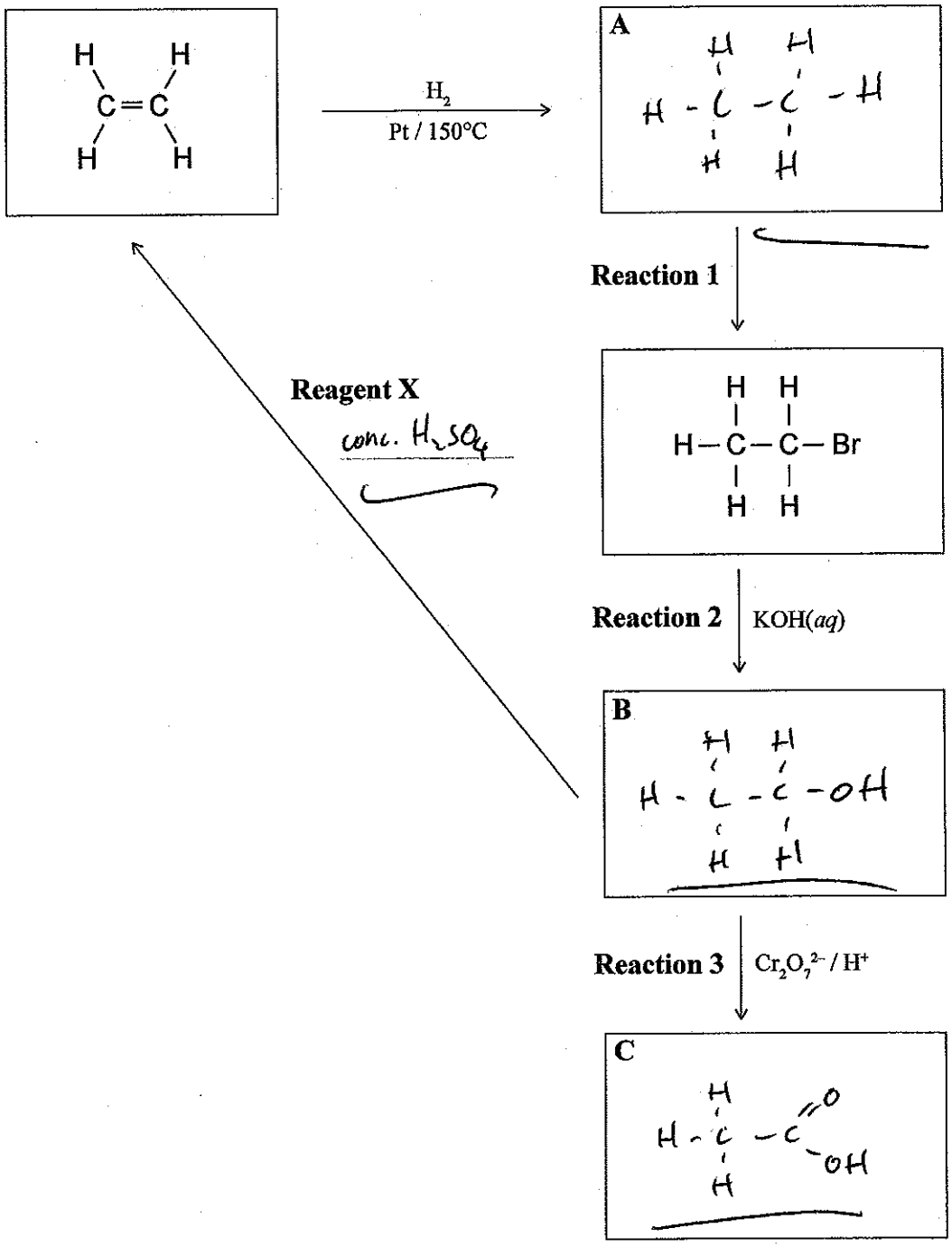
(a) (i) Complete the following chart by drawing the structural formulae for the organic compounds **A**, **B**, and **C** and identifying reagent **X**.



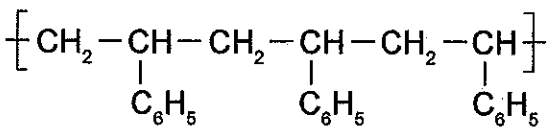
(ii) Identify the type of organic reaction occurring in each of Reactions 1, 2, and 3.

Reaction 1 substitution

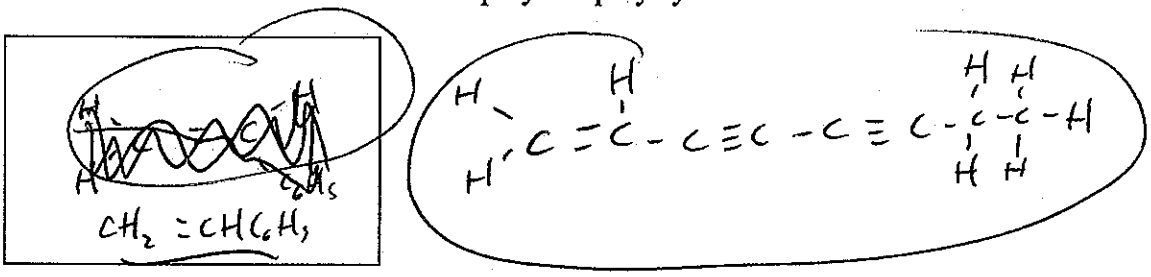
Reaction 2 substitution

Reaction 3 oxidation

(b) Polystyrene is a polymer with the structure:

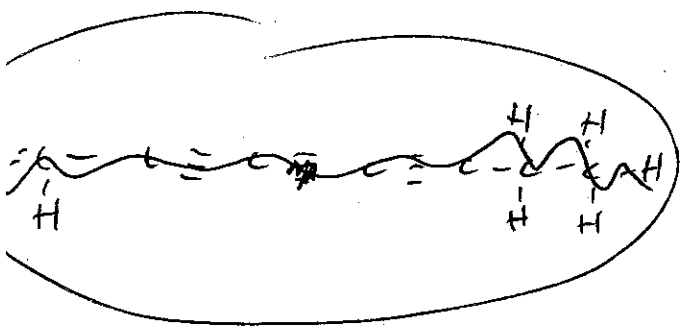


(i) Draw the monomer used to make the polymer polystyrene.



(ii) Explain why the formation of polystyrene from its monomer is classified as an addition polymerisation reaction.

An addition polymerisation reaction is when a double bond is broken and many ~~more~~ monomers are added together to form a polymer. To form polystyrene, the double bond of the monomer is broken which forms 2 free bonds. These bonds are then used to link many monomers together to form a polymer - polystyrene. It is an addition ~~reaction~~ polymerisation reaction because the double bond is broken and many monomers are added together to form a long chain of monomers which is the polymer polystyrene.



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(c) The reaction between propene, $C_3H_6(g)$, and hydrogen chloride, $HCl(g)$, produces a mixture of products.

One of these products, the major product, is made in higher proportions than the other, the minor product.

$$CH_2=CH-CH_3 + HCl \rightarrow$$

(i) Draw and name the major and minor products for this reaction.

Major Product	Minor Product
$CH_3-CH(Cl)-CH_3$	$CH_2(Cl)-CH_2-CH_3$
Name: 2-chloropropane	**Name:** 1-chloropropane

(ii) Elaborate on the reaction that occurs between propene and hydrogen chloride.

When propene and hydrogen chloride react they form a ~~fr~~ haloalkane. this haloalkane can ~~either~~ have the Cl bonded to either C1 or C2. Which one is the major product is determined by Markovnikov's "the rich get richer" rule. First propene's double bond is broken and 2 new ~~ban~~ free bonds occur. ~~The~~ In the major product, the hydrogen atom bonds to the carbon atom which already has the most hydrogen atoms bonded to it and the halogen atom ~~is~~ then bond to the other C atom in the double bond. In this case the H atoms bonds to carbon 1 as it has 2 H's already attached where as C2 only has 1. The Cl atom then bond to C2. In the minor product the H will bond to C2 and the Cl will bond to Cl. this results in the major product being 2-chloropropane and the minor 1-chloropropane. Both reaction are addition reactions as the double bond is broken and 2 atoms are added on

add

C-1

E7

Excellence exemplar 2016

Subject:	Chemistry	Standard:	91165	Total score:	22

Q	Grade score	Annotation
1	E7	In part (a), the candidate has correctly given all ten structures and names. In part (b), the correct classification has been applied to all three haloalkanes, linked to the reason for the candidate's choice for molecule A. A successful explanation of why the double bond and two different groups / atoms on the carbon atom are required for geometric isomerism is given for part (c). A link is also given to the molecule 1,2-dibromoethene. E8 was not awarded as the candidate failed to mention that both isomers have the same molecular formula.
2	E8	The candidate correctly identified both trends from the graph and named all four gaseous alkanes that exist at room temperature in part (a). In part (b), the candidate correctly wrote two equations and explained why carboxylic acids have acidic properties, which is due to the donation of H^+ ions and the formation of H_3O^+ ions. In part (c), the candidate compared and contrasted both reactions and included observations, conditions, reaction type and structural formulae.
3	E7	The candidate in part (a), correctly identified formulae, reagent and the reaction type. In part (b), the candidate gave the correct monomer structure and explained that polymerisation reactions occur when double bonds in the monomer free-up bonding spaces for monomers to join. In part (c), the candidate elaborated on the reaction by explaining how the two products are formed and discussed in detail, the positioning of H and Cl atoms in both. Excellence could not be awarded as the candidate did not consider that major and minor products are due to the asymmetry of propene.