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91165

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Level 2 Chemistry, 2017

91165 Demonstrate understanding of the properties of selected organic compounds

2.00 p.m. Thursday 16 November 2017
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 23

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QUESTION ONE

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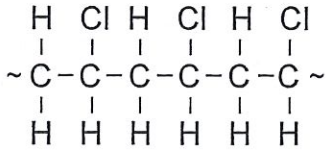
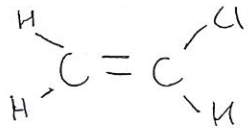
(a) Polyvinyl chloride (polychloroethene) is often used to make artificial leather. This can then be used to cover chairs, cover car seats, and make clothing.

A section of a polyvinyl chloride molecule is shown below.



(i) Draw the monomer from which the polymer polyvinyl chloride would be made.



(ii) Explain the difference in the structures and chemical reactivity of the monomer and polymer, and why the difference is important for the uses of the polymer.

The monomer, chloroethene, consists of a chain of two carbons bonded together by a double bond.

The polymer, polychoroethene, consists of a long chain of carbon atoms.

As a result, the polymer is much more strongly held together than the monomer, so is better for use as artificial leather. The polymer is also fully saturated, so is much less reactive compared to the unsaturated monomer.

4

1c

(iii) Making polyvinyl chloride (polychloroethene) from its monomer is called 'addition polymerisation'.

Explain the term 'addition polymerisation' using polyvinyl chloride as an example.

Include an equation in your answer.

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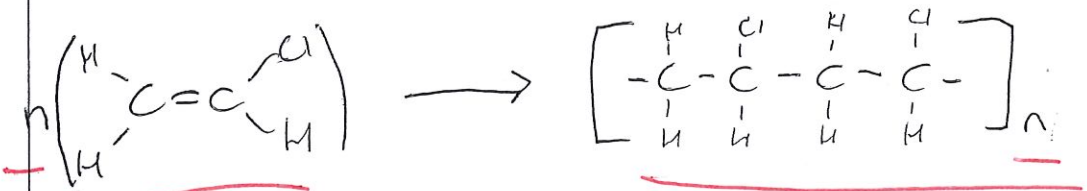
The reaction forming polyvinyl chloride is an addition polymerisation reaction, as the double bond of chloroethene is opened up, allowing each carbon to bond to another carbon from a different chloroethene molecule. This results in a chain of carbon atoms forming, resulting in the polymer polychloroethene being formed.

C-1

Equation:



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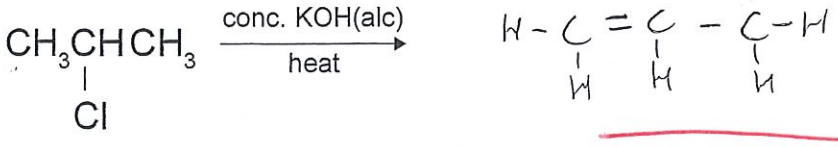
(b) A chemistry class was learning about the chemistry of haloalkanes. They were researching the effect of heat and concentrated potassium hydroxide in ethanol, conc. KOH(alc), on the haloalkane 2-chloropropane.

(i) Draw the organic product formed in the following reaction.



(ii) Explain how the functional group of the organic product drawn above could be identified.

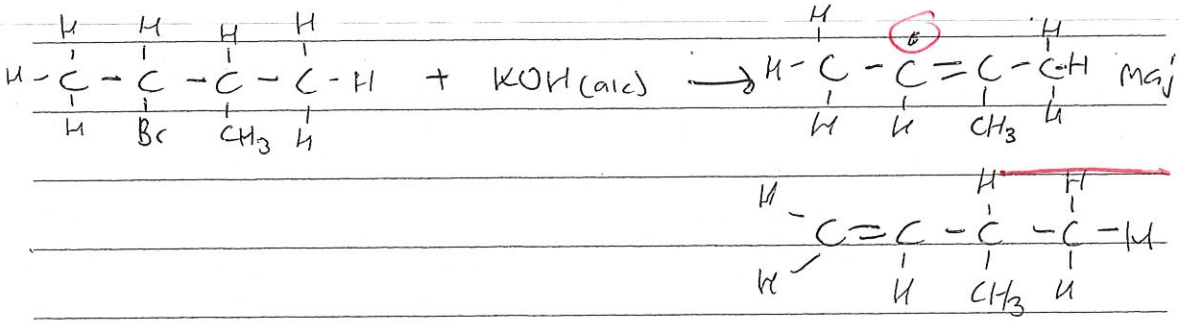
Take a sample of the organic product in a test tube. Then add Br_2 to the sample. It will undergo a colour change from orange to colourless. This is because an addition reaction would take place where the double bond will be opened up and two Br atoms will be added, one to each carbon of the opened double bond.

(iii) 2-bromo-3-methylbutane also reacts with conc. KOH(alc). However, in this reaction TWO organic products are formed, a major and a minor product.

Give an account of the chemical processes that occur in this reaction.

In your answer you should:

- write an equation for this reaction showing the organic compounds
- name the type of reaction occurring
- explain how the products form
- explain which product you would expect to be the minor product.



An elimination reaction occurs, where the Br atom is removed, along with an H atom, and a double bond is formed. Major and minor products form as the molecule is asymmetrical, and the H atom can be removed from either of the C atoms bonded to the C atom which was bonded to the Br atom. A H is more often removed from the C atom that is already bonded to the least amount of hydrogens. As a result, the major product is 2-methylbut-2-ene. The minor product is, as a result, 3-methylbut-1-ene.

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E7

QUESTION TWO

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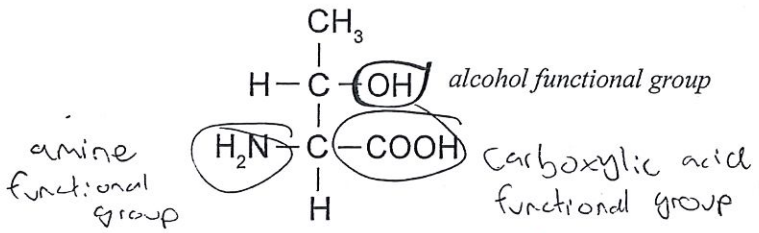
(a) The structure of a molecule of an organic compound, threonine, is shown below.



threonine

An alcohol functional group has been identified in the threonine molecule above.

(i) Circle and name **two other** functional groups on the threonine molecule above.

(ii) Classify the alcohol functional group as primary, secondary, or tertiary.

Secondary

(iii) Explain how you classified the alcohol group.

As the carbons bonded to the alcohol group is bonded to two other carbons, so it is secondary.

1

(b) Name the organic compounds in the table below.

Compound	IUPAC (systematic) name
$CH_3-CH_2-CH_2-C\equiv CH$	pent-1-yne
$CH_3-CH(Br)-CH(CH_3)-CH_2-CH_2-CH_3$	2-bromo-3-methylhexane
$CH_3-CH_2-CH(OH)-C(CH_3)(CH_3)-CH_3$	2,2-dimethylpentan-3-ol

4

(c) (i) Draw four alkene isomers for the organic compound C_4H_8 in the table below.

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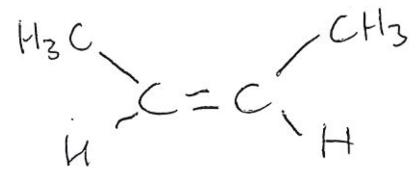
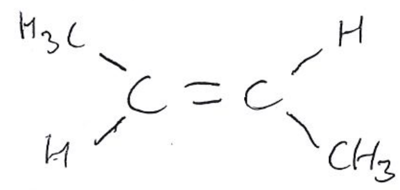
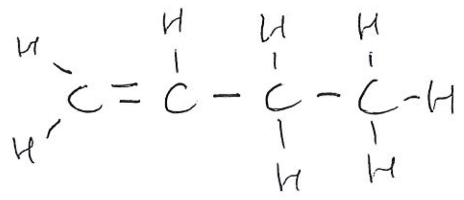
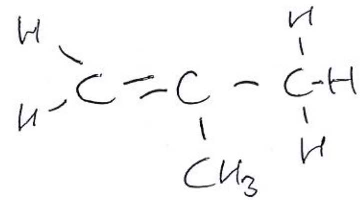
1.	**2.**
	
3.	**4.**
	

(ii) Identify the compounds that are *cis* and *trans* (geometric) isomers from the table above.

	cis	trans
Number	1	2

Justify your choices, and explain why only these two compounds are *cis* and *trans* (geometric) isomers.

In order to form cis trans geometric isomers, a compound must consist of a double bond to prevent rotation, and the atoms or groups attached to each carbon of the double bond must be different.

Both 1 and 2 have double bonds, and each carbon of the double bond is attached to a methyl group and H atom, so can form geometric isomers. 3 has two H atoms attached to a carbon of the double bond, so can not, and 4 has two methyl group [illegible] carbon so can not either

(d) Alkanes and alkenes can be identified by their reactions with a solution of bromine water, $Br_2(aq)$.

Contrast the types of reactions an alkane and an alkene will undergo with an orange solution of bromine water.

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An alkene will undergo an addition reaction with Br_2 to form a haloalkane, as the double bond is opened up and Br_2 atoms are added to each carbon of the previous double bond. No special conditions are required, and the colour change of orange to colourless will occur quickly.

An alkane will undergo a substitution reaction with Br_2 to form a haloalkane also, as an H atom is removed and replaced with a Br atom. This reaction requires U.V. light to occur, and the colour change of Orange to colourless will occur much slower, as the reaction takes longer to take place.

C

So both alkenes and alkanes will react with Br_2, but the alkene will react much quicker, and the alkane will require U.V. light.

E8

QUESTION THREE

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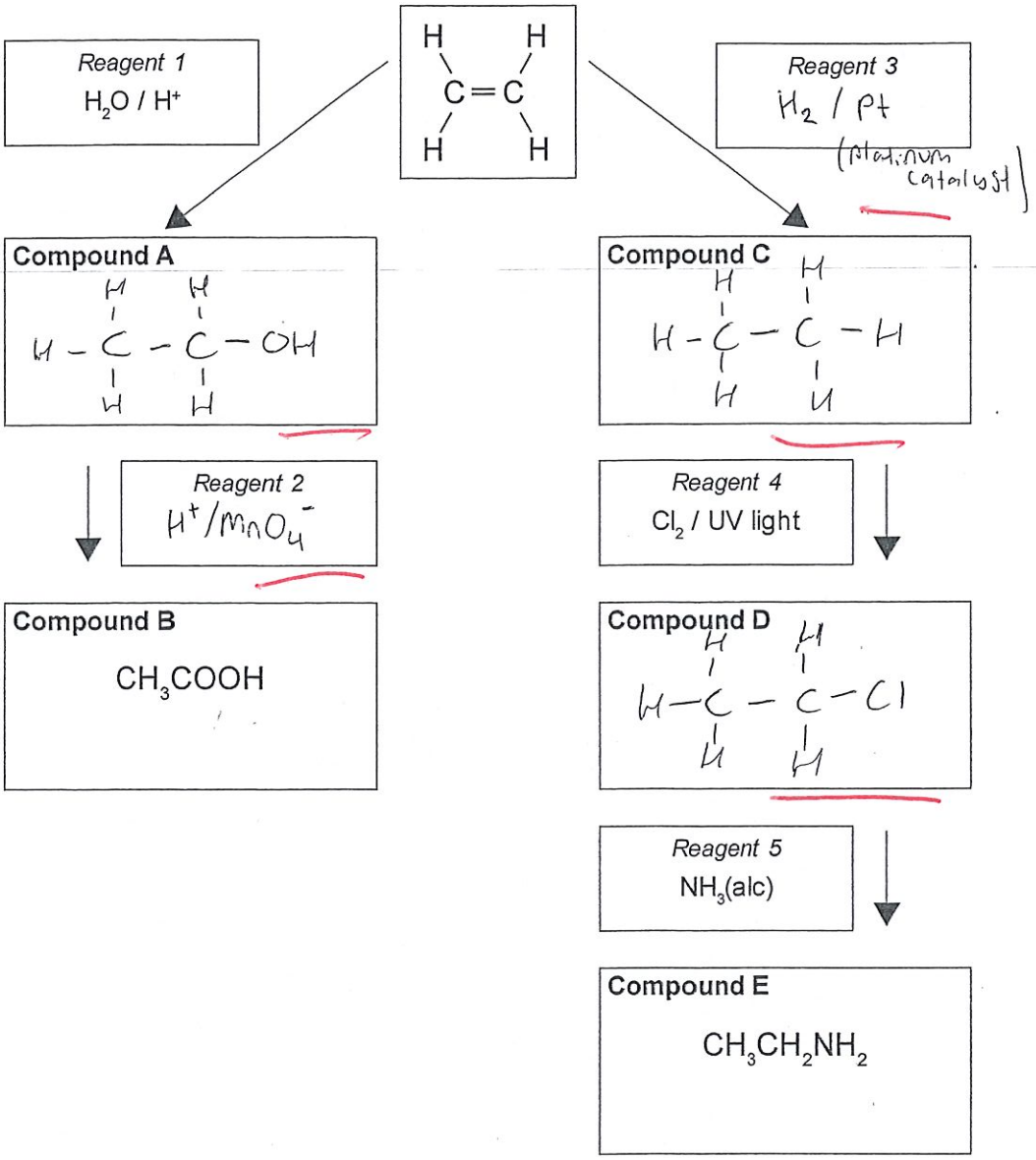
(a) (i) Complete the following reaction scheme by drawing the structural formulae for the organic compounds **A**, **C**, and **D**, and identifying *reagents 2 and 3*.



(ii) Identify the types of reactions that occur to produce compounds **A, B, C, D**, and **E**:

A. addition

B. Oxidation

C. addition

D. substitution

E. Substitution

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(b) Describe a simple test that will distinguish between solutions of the final organic compounds **B** and **E**.

Add damp litmus paper to both solutions. The solution which turns blue litmus paper red is B, a carboxylic acid. The solution which turns red litmus paper blue is E, a amine, which is basic.

(c) Compounds **B** and **E** react together.

(i) Write a balanced equation for the reaction that occurs between compounds **B** and **E**.

$$CH_3COOH + CH_3CH_2NH_2 \longrightarrow CH_3COO^- + CH_3CH_2NH_3^+$$

(ii) Identify the type of reaction that occurs between compounds **B** and **E**.

Justify your answer.

An acid base neutralisation reaction has occurred. This is because the carboxylic acid ethanoic acid has reacted with the basic amine ethanamine to form the ethanoate and ethyl ammonium ions. Ethanoic acid being acidic means it donates a proton to the basic ethanamine, a proton acceptor, to form these ions.

C

(d) Explain how compound **A** from the reaction scheme could be directly converted into compound **D**.

By adding PCl_5 to compound A, ethanol, a substitution reaction would occur which would result in the OH group being replaced with a Cl atom. This would form compound D, chloroethane.

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1

E8

Excellence exemplar for 91165 2017		Total score	23
Q	**Grade score**	**Annotation**	
1	E7	The candidate was awarded E8 for the following reasons: in part (a), the correct monomer was drawn and the link was made between the polymer property (strength of forces and reactivity) and the use, also addition polymerisation was explained with a correct equation; in part (b), the candidate correctly drew the organic product and gave correct observations for a chemical test for an alkene. A full account was given for the major and minor isomers formed. E7 was awarded as the candidate did not specifically mention the formation of single covalent bonds for part (a)(iii), this counted as one minor error.	
2	E8	The candidate was awarded E8 for the following reasons: in part (a), both functional groups were correctly identified and named and the correct classification was explained; in part (b), all compounds were correctly named; in part (c), all isomers were drawn correctly and the candidate was able to justify why but-2-ene formed geometric isomers and why the other isomers could not; in part (d), the candidate elaborated on and contrasted both reactions with the correct observations and number of Br atoms. A minor error was issued in part (c) for not discussing the positioning of the groups in cis / trans isomers, however, one minor error in this question still equated to a grade score of E8.	
3	E8	The candidate was awarded E8 for the following reasons: in part (a), the candidate correctly identified all formulae, reagents and reaction types; in part (b), a correct simple test was described; in part (c), a correct equation and justification of the reaction type was given; in part (d), the candidate gave a correct explanation of the reaction conversion. A grade score of E8 was awarded as the candidate's responses were flawless.	