Tutorial Letter 202/2/2017

General Chemistry 1B

CHE1502

Semester 2

Department of Chemistry

This tutorial letter contains important information
about your module.

Define tomorrow.

UNISA
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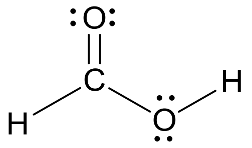
SECOND SEMESTER ASSIGNMENTS

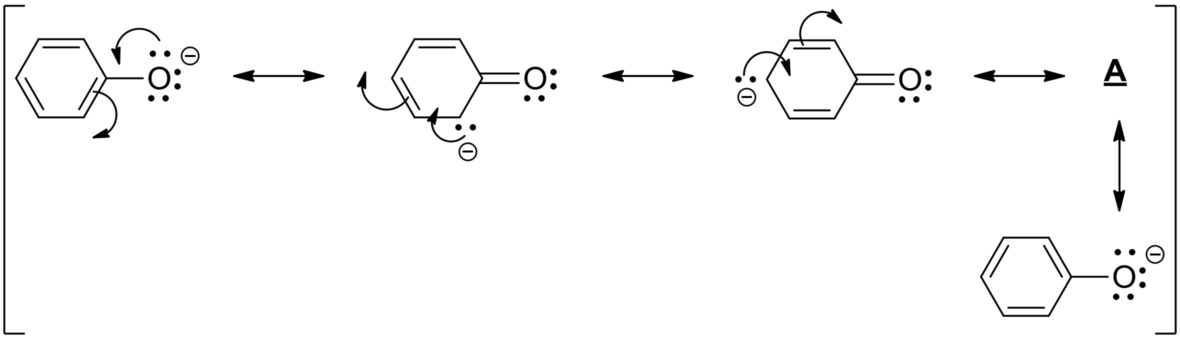
ONLY FOR SEMESTER 2 STUDENTS

ANSWERS TO PART B OF ASSIGNMENT 2

1. The Lewis structure for a molecule with molecular formula CH_2O_2:

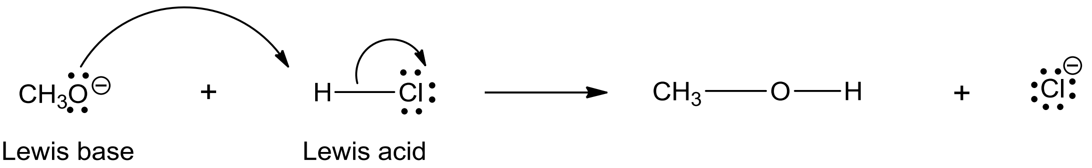


2. The resonance forms showing the delocalization of charges are shown below:



You have to complete the representation above by drawing the structure of **A** and indicating the movement of electrons with curved arrows to produce the last structure.

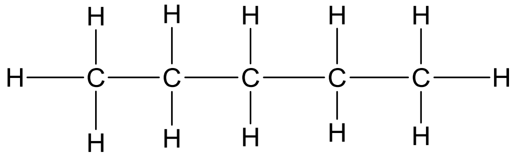
3. The answer is:



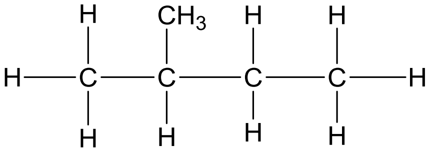
A Lewis base is a species that have a pair of electrons that can be donated to form a new bond. A Lewis acid is a species that can accept a pair of electrons - species having a positive charge or an empty orbital are examples of Lewis acids.

In the above example, the Lewis base is the compound having the negatively charged O with lone pairs of electrons, which can be donated to the Lewis acid (created when the C-Cl bond breaks). The curved arrow always start at the center or atom that donates electrons and ends at the atom that accepts the electrons.

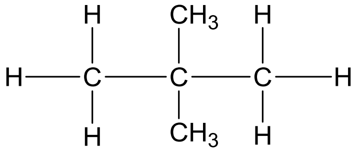
4. The structural isomers must all have the molecular formula of C_5H_{12} but the atoms must be connected differently. Three possible structural isomers with the IUPAC names are:



Pentane

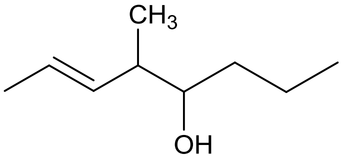


2-methylbutane



2,3-Dimethypropane

5. (a) The compound with proposed name of 4-methyloct-5-ol-2-ene has the following structure:

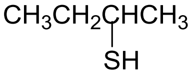


(b) The numbering is from the wrong side of the molecule. Because the compound contains an OH group, it is an alcohol. According to the IUPAC nomenclature rules, the numbering should take place to give the position of the OH group the lowest possible number. The numbering should start from the right with the position of the OH on C-4 that had to be indicated as '4-ol'. The ending of the name is incorrect and the name should end with '–ol' not '–ene'.

The carbon-carbon double bond should be indicated before the ending of the name and the number of the carbon atom where the carbon-carbon double bond starts is C-6 not C-2 and should have been indicated as '6-en' and not '2-ene'. The one methyl group, which is a substituent on carbon-5 chain and not on carbon-4.

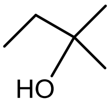
The correct IUPAC name for the compound is **5-methyloct-6-en-4-ol**.

6. (a) The product formed in the reaction is:

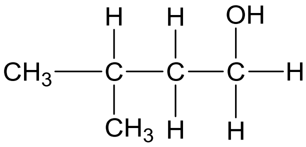


$$CH_3CH_2\underset{SH}{\underset{|}{C}}HCH_3$$

(b) The product in the acid catalyzed hydration of 2-methyl-2-butene is:

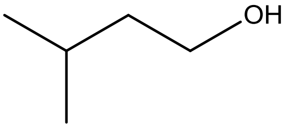


(c) The product is:



$$CH_3-\overset{H}{\underset{CH_3}{C}}-\overset{H}{\underset{H}{C}}-\overset{OH}{\underset{H}{C}}-H$$

Another representation of the product is:



(d) The anti Markovnikov addition- Br adds to CH_2 and H adds to CH to produce:

$$CH_3CH_2\text{-}CH_2-Br$$

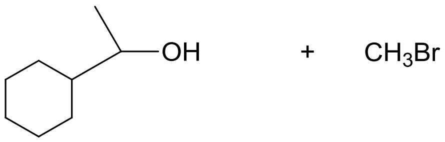
(e) The final product is:

$$CH_3C\equiv C-CH_3$$

The product forms via the intermediate step:

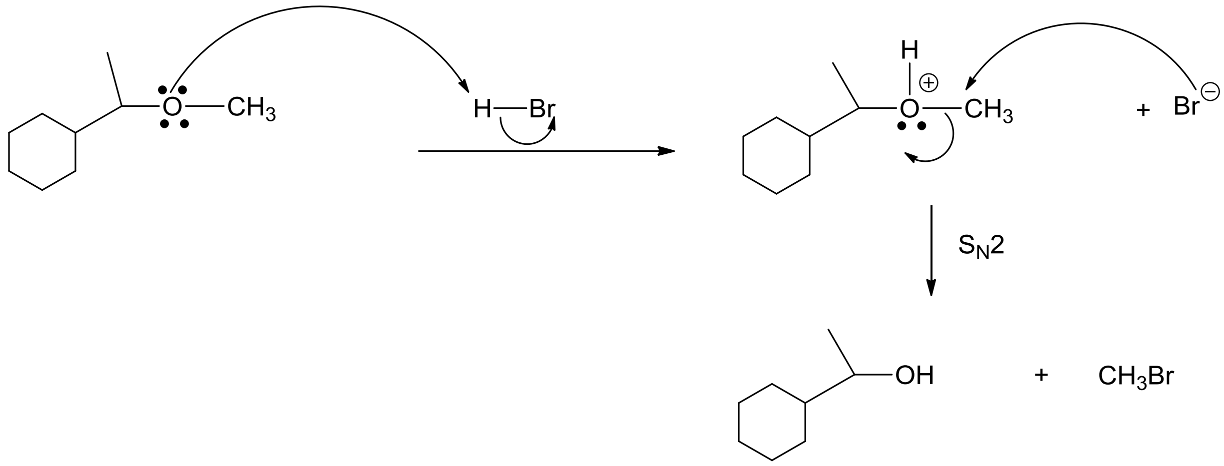
$$CH_3C\equiv CH \xrightarrow{NaNH_2} CH_3C\equiv\overset{\ominus}{C}\!:\ \overset{\oplus}{Na} \xrightarrow{CH_3Br} CH_3C\equiv C-CH_3$$

(f) The products formed in the reaction are:



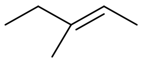
The above products form when there is a 1:1 ratio of the ether and HBr. When the HBr is in excess, the alcohol that forms above can further react with an HBr molecule to give an alkyl halide. (Br replaced the OH).

[Explanation: The reaction proceeds as follows:



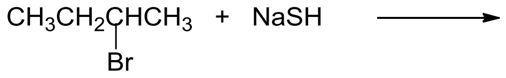
]

(g) The major product is:



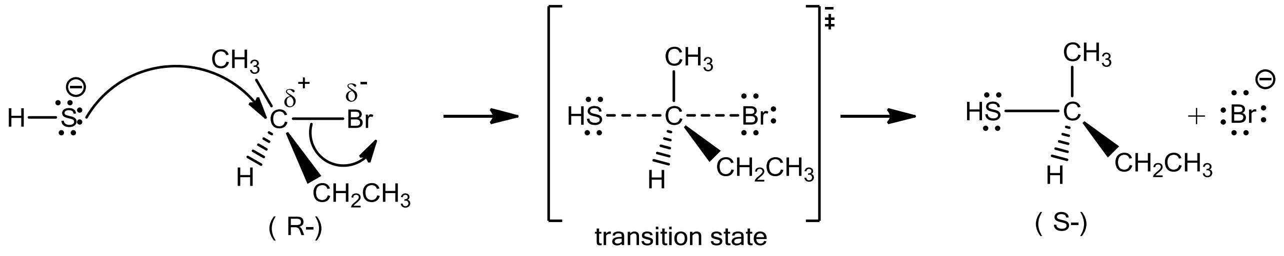
7. The detailed reaction mechanism for the reactions shown in:

(i) Question 6 (a)

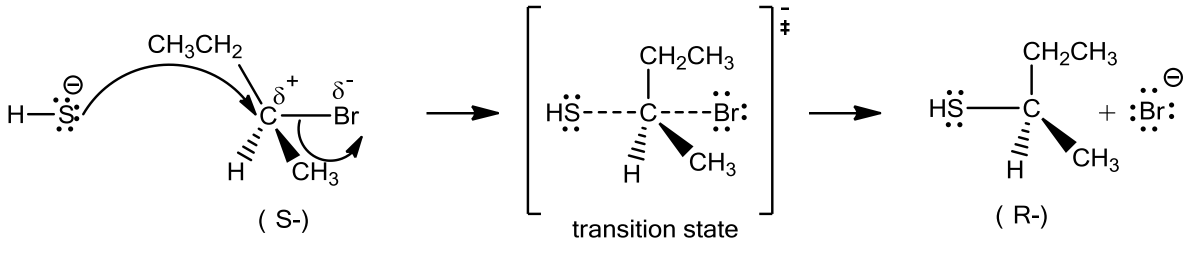


$$\underset{\displaystyle Br}{CH_3CH_2CHCH_3} + NaSH \longrightarrow$$

The ${}^-SH$ is a strong nucleophile, which promotes nucleophilic substitution via a S_N2 reaction mechanism. 2-Bromobutane is a chiral compound and can exist either as the R- or S-enantiomer. The mechanism for the reaction of each enantiomer is given below:



Or



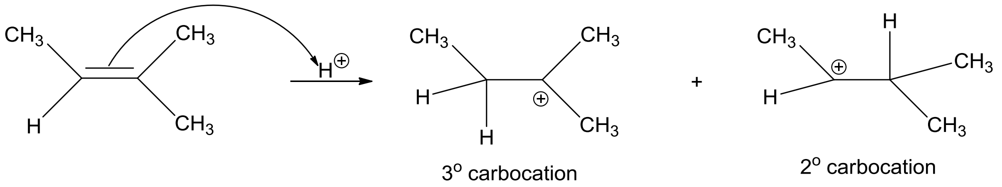
The reaction occurs with inversion of configuration.

(ii) Question 6 (b)

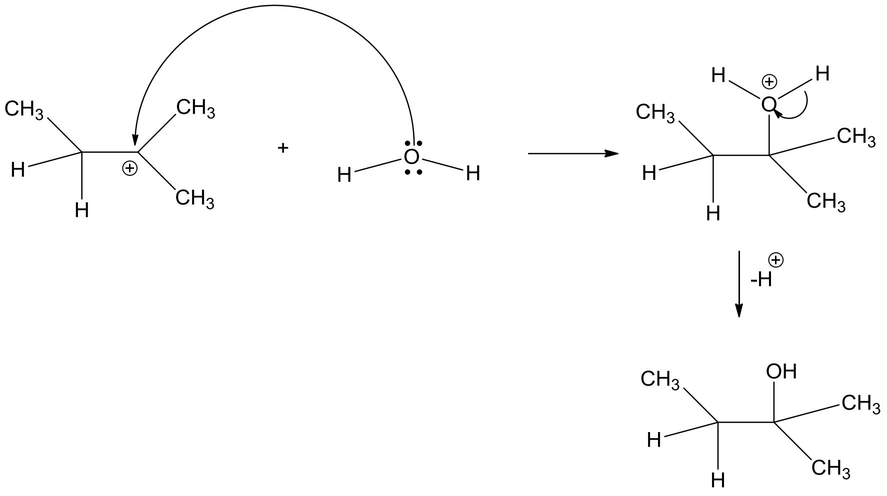
The reaction equation is:

The reaction mechanism

The first step in the acid catalyzed hydration of 2-methyl-2-butene with 2-methyl-2-butene redrawn is:



The most stable carbocation is the tertiary carbocation which is lower in energy than the secondary carbocation and is mainly formed. The reaction of the tertiary carbocation will give the predominant / major product.

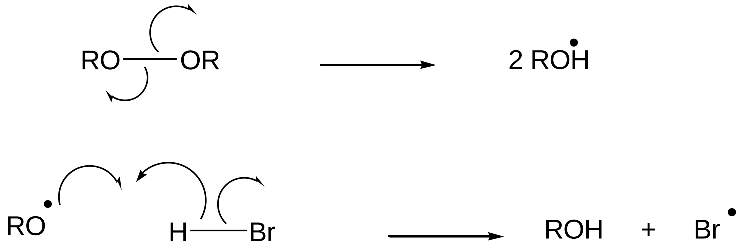


[Explanation: The nucleophilic water molecule attacks the electrophilic carbocation, i.e. O contains a lone pair of electrons that are donated to the C^+ to form a bond].

(iii) Question 6(d)

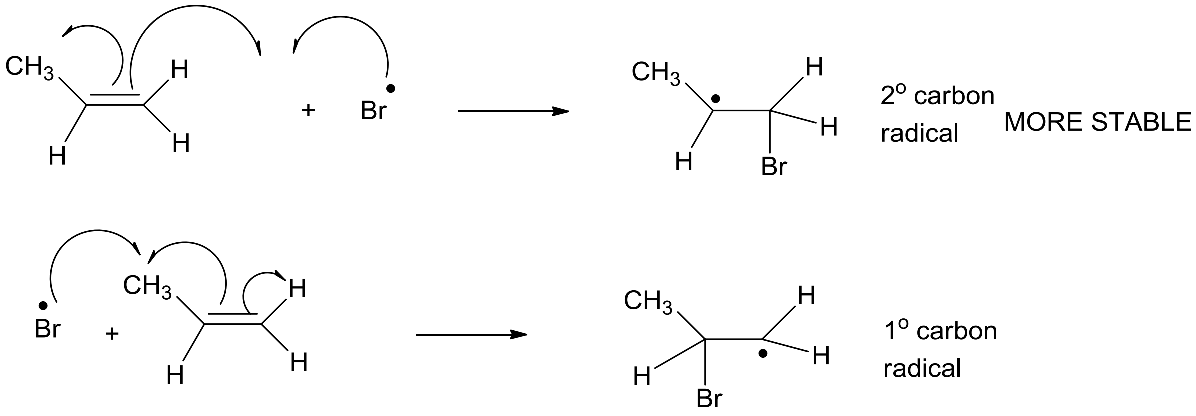
Alkenes react with hydrogen halides in the presence of peroxides to give alkyl halides via an anti Markovnikov addition method. The reaction proceeds as follows:

Initiation:



Propagation:

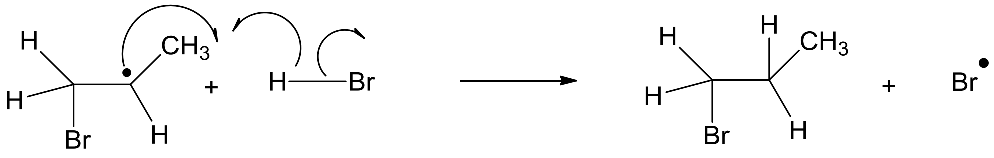
Step 1 This bromine radical adds to the carbon-carbon double bond to form an alkyl radical. The alkene can form two possible alkyl radicals:



The more stable radical intermediate that is mostly formed in the reaction leads to the formation of the major product. Stability of carbon radicals:

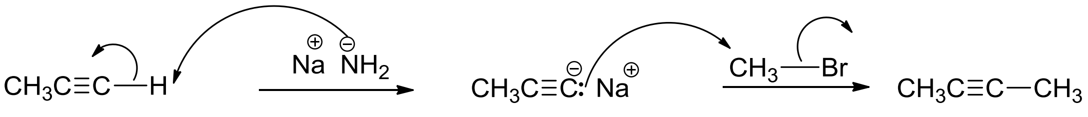
$$3^{o} > 2^{o} > 1^{o} > \text{methyl}$$

Step 2 The alkyl radical abstracts a hydrogen atom from HBr to generate the product and a bromine radical.

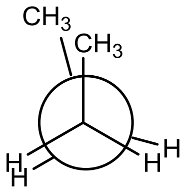


The bromine radical produced in step 2 reacts further in step 1, continuing the chain.

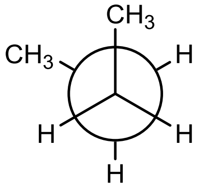
(iv) Question 6 (e)



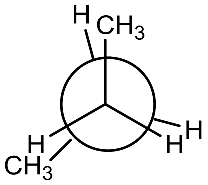
8. The Newman projections for the different conformations of $CH_3CH_2CH_2CH_3$, butane:



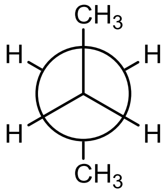
Totally eclipsed



Gauche/ Staggered



Eclipsed



Anti/Staggered conformation

Explanation:

All the structures represent different conformations of butane. The last structure is a staggered conformation with the largest groups (two CH_3 groups) being the furthest apart (LEAST interaction between the largest groups) and is called the anti-conformation. The anti-conformation is the most stable conformation and therefore has the lowest energy.

The second structure from the left is also a staggered conformation and the largest groups are closer to one another than in the last structure. This conformation is called the gauche conformation. This conformation is less stable (higher energy) than the anti-conformation.

In the first and third conformations, the bonds and groups of C-1 and C-2 are behind one another and they are called eclipsed conformations. The groups in the eclipsed conformations are therefore closer to one another than in the staggered conformations, therefore all the eclipsed conformations are of higher energy and less stable than the staggered conformations.

The first structure is an eclipsed conformation that is the least stable of all the conformations because the largest groups are the closest to one another than in the other conformations. This conformation is also referred to as the totally eclipsed conformation (the largest groups are eclipsed).

In the third conformation is also an eclipsed conformation, but the largest groups are not eclipsed and therefore this conformation is more stable than the first conformation.