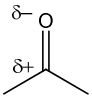
CHEM1902/4 Worksheet 4 – Answers to Critical Thinking Questions

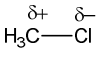
The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Module 6: Polar Reactions

1. See below.



large



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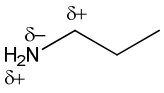

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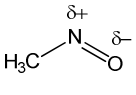
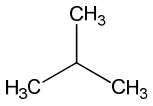
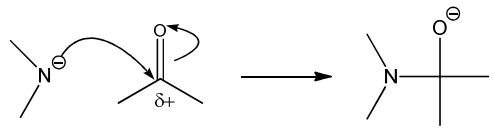


large



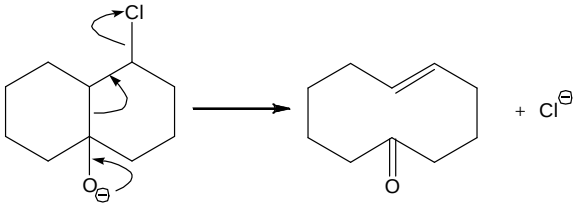
very small

2. The negatively charged N atom will attack the δ+ carbonyl C atom. A new N-C bond will form.
3. A bond would need to break. The π bond in the C=O group is the weakest and would break.
4. See below.



nucleophile electrophile

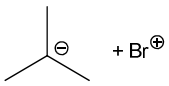
5. See above.
6. See below.



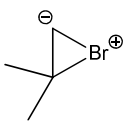
7. A stepwise reaction would involve the processes represented by the 3 arrows occurring separately. If either of the first two arrows are drawn on their own, a pentavalent carbon is formed. The third arrow would generate a positively charged secondary carbon.

   A concerted reaction avoids these issues. It is more likely as the new bonds are made at the same time as bonds are broken, minimizing the activation energy required.

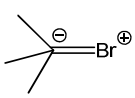
Extension



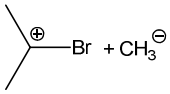
Leads to a positive charge on the more electronegative element.



Leads to a 5-valent carbon atom.



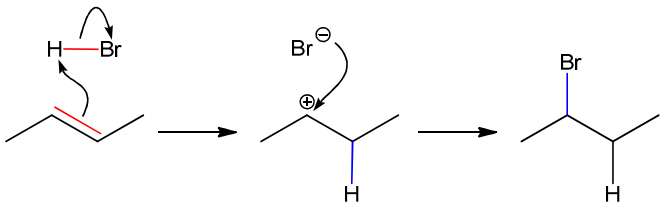
Leads to a 5-valent carbon atom.



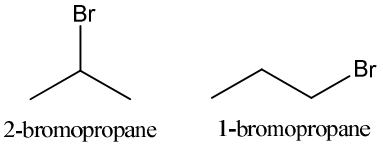
Heterolytic cleavage of a non-polar bond to form 2 charged carbon species.

Module 7: Electrophilic Additions

1. Nucleophile
2. Broken = red. Formed = blue.



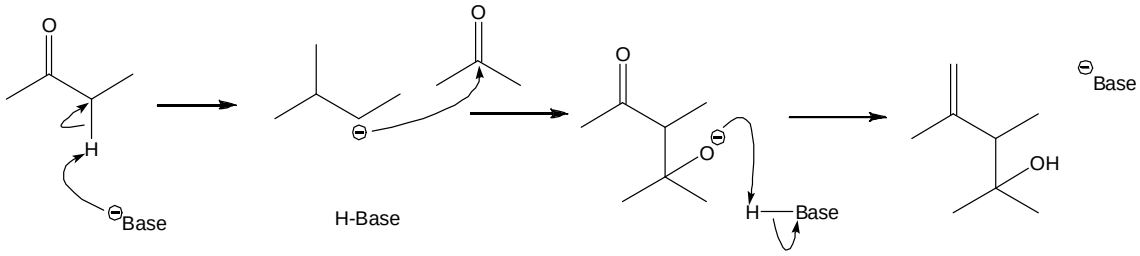
3. See above.
4. See below. The major product is 2-bromopropane.



5. The catalyst speeds up the reaction by lowering the energy required for the reactions.
   In the acid catalysed reaction, H_2O is not sufficiently electrophilic to initiate the reaction. H^+ is a much better electrophile.
   In the hydrogenation reaction, H_2 adsorbs on the Pd surface and the H-H bond breaks. This activates the electrophile.

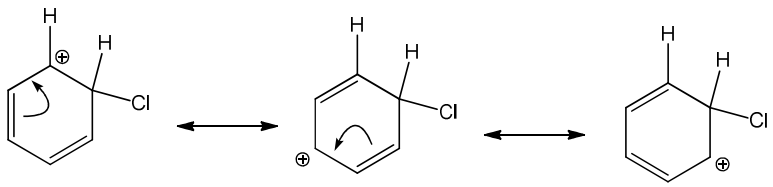
Extension

The aldol condensation is a nucleophilic addition reaction whereas addition to alkenes is an electrophilic addition.



6. $FeCl_3$ is a catalyst. It forms a highly electrophilic complex, transforming the non-polar Cl_2 molecule into a good electrophile.

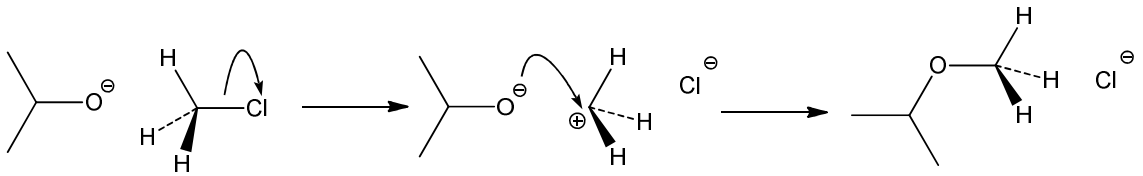
7. See below. The resonance stabilises the intermediate.



8. CH_3CH_2Cl with a Lewis acid catalyst such as $FeCl_3$ or $AlCl_3$ is used.

Module 8: Nucleophilic Substitution

1. See below.



2. S = substitution, N = nucleophilic, "1" = unimolecular (key or *rate determining* step involves 1 molecule) and "2" " = bimolecular (key or *rate determining* step involves 2 species).

3. The first reaction is likely to occur via S_N2. The carbon atom at which the nucleophilic attack occurs in this pathway is not very crowded. The S_N1 pathway would lead to a positive charge on a primary carbon atom, which is highly unstable.

   The second reaction is likely to occur via S_N1. This pathway leads to a positive charge on a tertiary carbon which is stabilised by hyperconjugation. The S_N2 pathway would involve attack on a crowded carbon atom.

Key to success: practice further by completing this week's tutorial homework

Key to even greater success: practice even further by completing this week's suggested exam questions