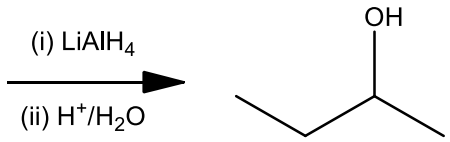
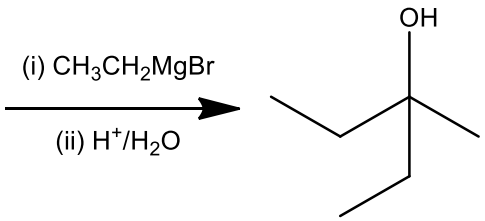
CHEM1102 Worksheet 7 – Answers to Critical Thinking Questions

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

Model 1: Addition to a Carbonyl

1. See below.

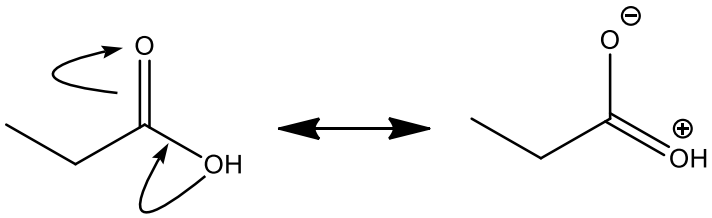




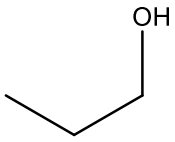
2. The first product is chiral and a racemic mixture will be produced. The second product is achiral.

3. An aldehyde is *more* electrophilic than a carboxylic acid.

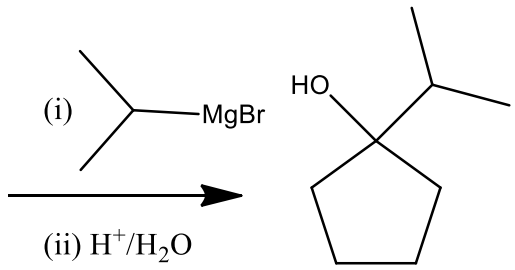
   There is resonance stabilization of the carboxylic acid, see below, which acts to reduce the partial positive charge on the carbonyl C atom.

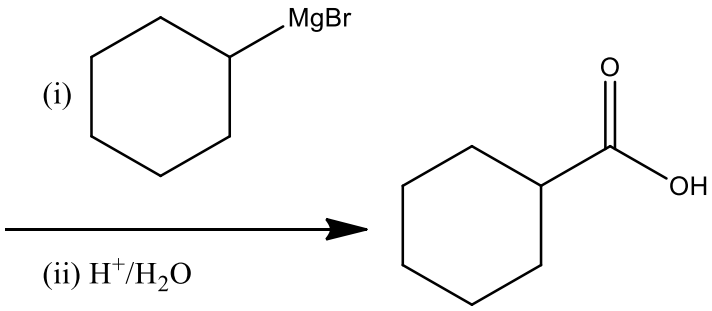


4. $LiAlH_4$ will reduce a carboxylic acid to the carbonyl level. As the carbonyl is *more* reactive, this will *also* be reduced. The overall reaction therefore results in reduction all the way to the alcohol:



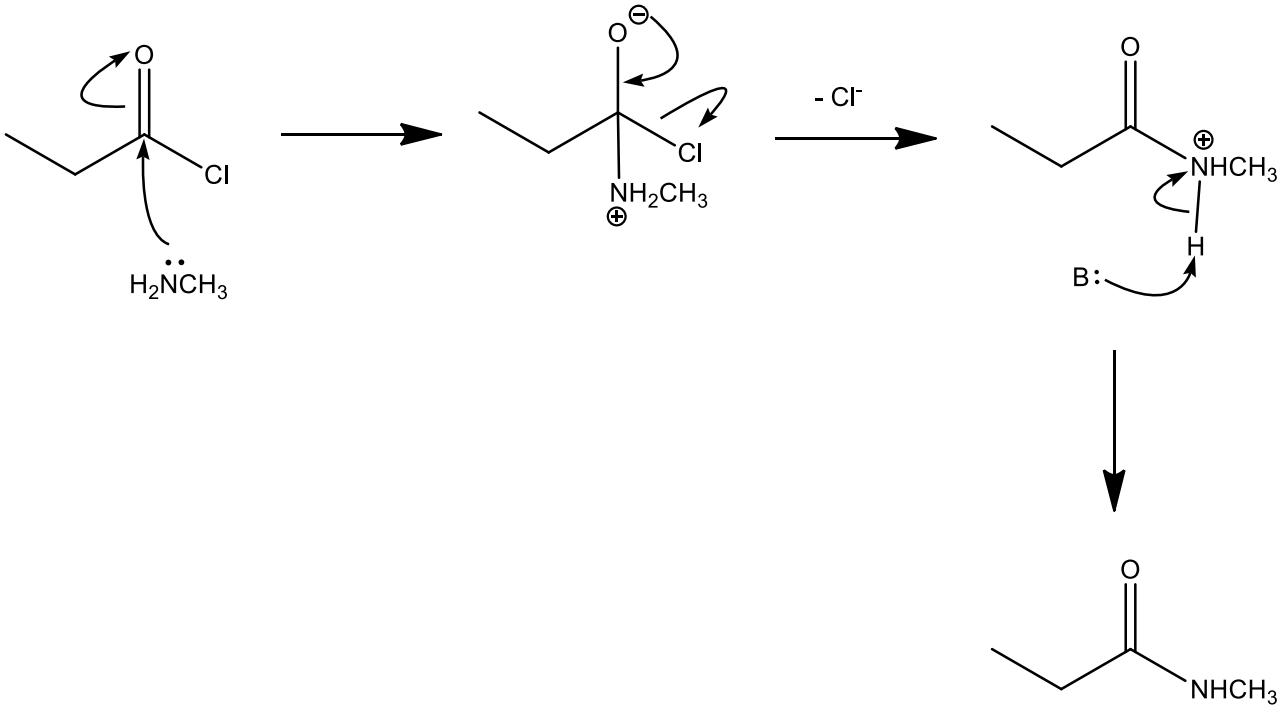
5. See below.



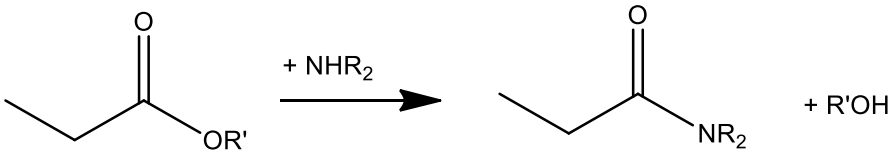


Model 2: Carboxylic Acid Derivatives

1. See below. The base, B, could be solvent or H_2NCH_3.



2. Addition of an amine:

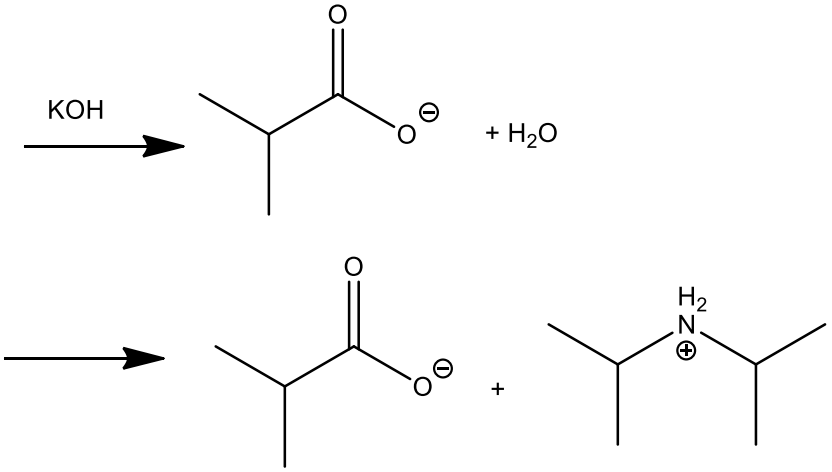


3. An alcohol (with its alkyl group corresponding, as shown above, to the –OR' group in the ester.

Extension.

The resonance stabilization shown in Model 1 Q3 is key. As nitrogen is less electronegative than oxygen, it is more able to donate it lone pair and so the second resonance form is more important in amides than in acid anhydrides and esters. The resonance stabilization requires good overlap of the *p*-orbital holding the lone pair and the C=O π orbital. As Cl is larger than O or N, the C-Cl bond is long and the overlap is poor: little resonance stabilization occurs in the acid chlorides.

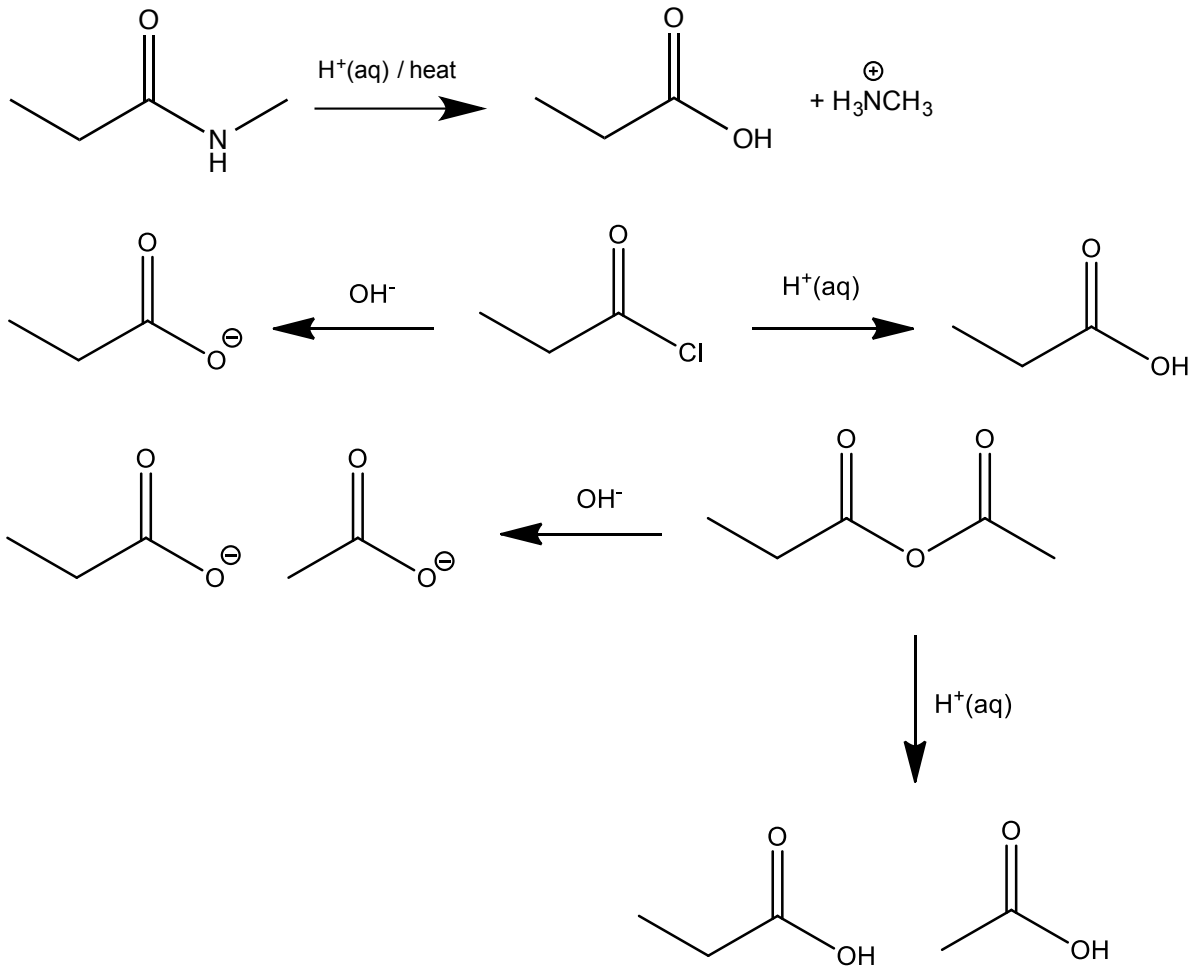
4. Simple H^+ transfer reactions occur:

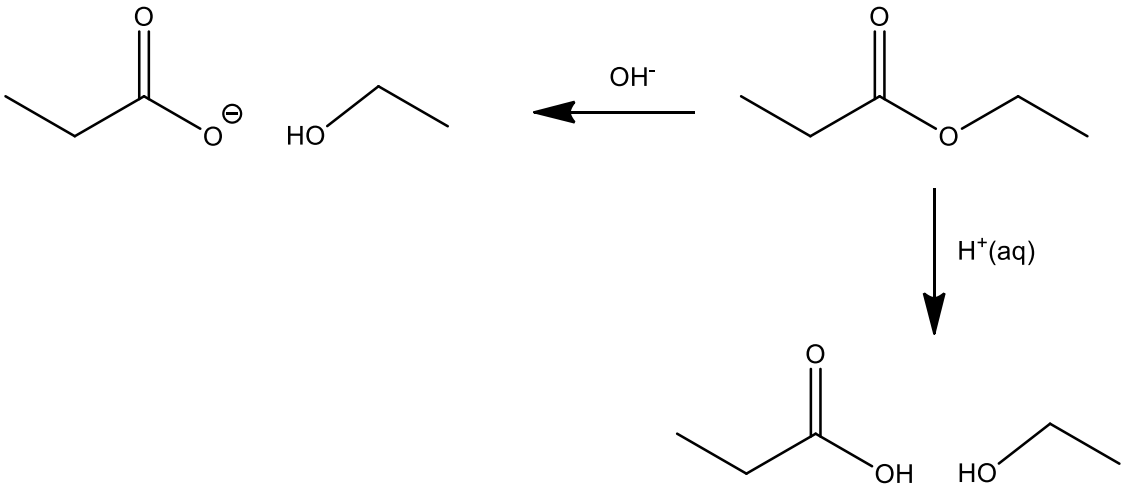


5. Step 1: CH_3OH is added and H_2O is removed. The acid and alcohol *combine* to make an ester in the *condensation* reaction.

   Step 2: H_2O is added and CH_3OH is removed in this *hydrolysis* reaction.

6. See below.





7. An acid chloride is more reactive to nucleophiles like water than an amide.