Lucas Test

Functional Group(s): 3°alcohols, *some* (but not all) 2 °alcohols, 1°,2°,3° allylic alcohols
Known(s): 1-butanol (1 °); 2-butanol (2 °); tert-butyl alcohol (3°), phenol, decene

This test is for alcohols with six or fewer carbons. The unknown must be soluble in the reagent in order for this test to be valid.

Procedure

Set up 6 small (12 X 75mm) test tubes in a test tube rack in the hood. Label the test tubes #1-6 Add ~5 mg of a solid unknown/known or 0.5ml of a liquid unknown/known to each tube. Use test tube #1 for the unknown and tubes # 2-6 for each of the known alcohols to be tested. Add 1ml of the Lucas reagent to tubes #1-6. Vortex the mixture for 2 minutes, then allow the tube to sit undisturbed for 3-5 minutes. Observe each tube for formation of an insoluble layer, emulsion or color change and compare the results of the unknown with the known compounds.

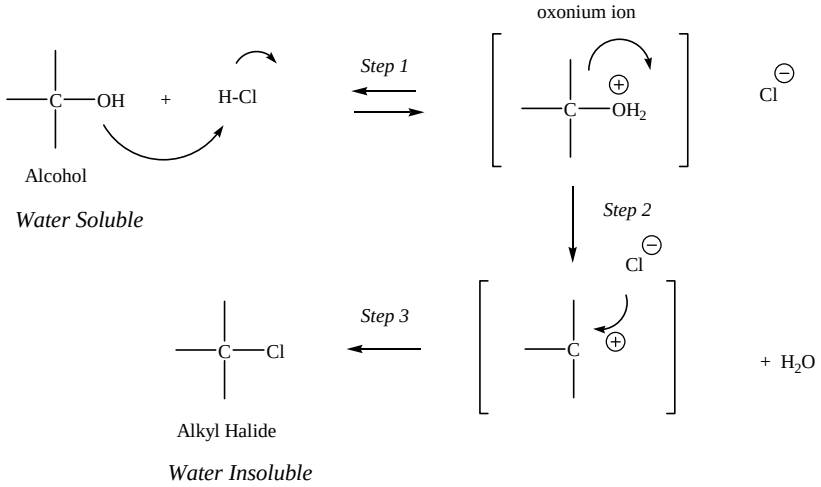
Results

An insoluble layer, cloudiness, color change (red or orange) or an emulsion will form with 1°, 2°, 3° allylic, 3° alkyl and *some* 2 ° alcohols and constitutes a "positive" result. Students should compare his/her results of the unknowns with the results for known compounds when trying to decide whether a result is positive or negative. Alkenes may give a "false" positive result due to HCl reacting with the alkene through an electrophlic addition. Phenols and enols will not give a positive result.

Theory

The Lucas reagent is an aqueous solution of strong acid (HCl) and zinc chloride. The alcohol starting material must be sufficiently soluble in aqueous environments (i.e., the Lucas reagent) for the reaction to take place. Therefore, only water-soluble, 1°, 2°, 3° allylic, 3° alkyl and some 2 ° alkyl alcohols of low molecular weight will provide positive results in this test.

The reaction that occurs in the Lucas test is an SN_1 nucleophilic substitution. Only alcohols that can generate stable carbocation intermediates will undergo the reaction. The acid catalyst activates the OH group of the alcohol by protonating the oxygen atom. The C-OH_2^+ bond breaks to generate the carbocation, which in turn reacts with the chloride ion (nucleophile) to generate an alkyl halide product. A general mechanism for this SN_1 reaction is provided below.



The alkyl chloride product that is generated in the reaction will not be water-soluble and causes cloudiness, an emulsion or a new "organic" layer to form in the reaction mixture, or sometimes only a color change will be observed (red or orange). Alkenes may react with the HCl in the Lucas reaction via an electrophilic addition to give a "false" positive result.