# Classification tests for carboxylic acid and derivatives essay

Classification Tests for Carboxylic Acid and Derivatives Mary Catherine Sarte, John Emmanuel Sy, Allurie Umel, Franklin Yap, Mary Christine YouIntroduction Carboxylic acids derivatives are simply groupsof compounds that contain a carbonyl group butwith an electronegative atom attached to thecarbon. The difference in the structure leads to amajor change in reactivity. The reactions of thesegroups of compounds involve nucleophilicsubstitution. Although there are abundant kindsof carboxylic acid derivatives, the experimentonly focuses on the common ones: acid halides, acid anhydrides, esters and amides.

Carboxylic acids and their derivatives areusually seen in industrial processes and mostbiological pathways. Esters can be seen as fatsand within the cell membrane. Esters are alsopresent in pleasant smelling liquids that areresponsible with the fragrant odor of fruits andflowers. Amides are also present in animalprotein and also in industrial products such asnylon. Acid chlorides and acid anhydrides areused in the synthesis of carboxylic derivatives. These are not usually found in nature because of its high reactivity property. One property of carboxylic acids is that theyare acidic.

Because of these, carboxylic acids aremostly made to react with bases such as NaOH toyield a water soluble metal carboxylates. Carboxylic acids and their derivatives reactwith nucleophiles which yields a formation of alcohol. The initially formed intermediate productexpels one of its substituents which is originallybonded to the carbonyl carbon forming a newcarbonyl compound. The reaction is callednucleophilic acyl substitution reaction. The procedure for acyl halides, acid anhydrides, esters and amides is hydrolysis. Hydrolysis issimply the reaction with water to yield acarboxylic acid.

Also for acetyl chloride isalcoholysis: Schotten-Bauman Reaction. It is thereaction with an alcohol to yield an ester. Thealcohol used here was ethanol. Again for acetylchloride and acetic anhydride, the reaction usedwas aminolysis: anilide formation. Aminolysis isthe reaction with ammonia or amine to yield anamide. In this case, aniline was the ammonia andanilide, an amide, was produced. Hydroxamicacis test was used for ethyl acetate andacetamide. Through this experiment, students are able tovisualize, through the different reactions, thenecleophilic acyl substitution reaction orcarboxylic acids and it derivatives. The differentclassification tests for such are also observed. Experimental A. Hydrolysis of Acid Derivatives Acyl halides and Acid anhydrides 1 ml of water was placed in a test tube. 10drops of the sample, in this case acetyl chlorideand acetic anhydride, was added in a drop wisemanner. A warming effect was noted. The firstresulting mixture was divided into two portions. To the 1 st , 1 ml of 2% $AgNO_3$ was added. Precipitation was observed. To the secondmixture, 1 ml of saturated $NaHCO_3$ was added. An evolution of gas was observed.

Esters 2ml of 25% NaOH solution was added to 1 mlof ethyl acetate. The mouth of the test tube wascovered and the test tube was heated in a boilingwater bath for about 5 minutes. The mixture wasthen neutralized with 10% HCL solution. With awafting motion, the odor of the solution wasnoted. Amides 1ml of benzamide was treated with 5ml of 10%NaOH solution. The solution was then heated toboiling. While heating, the test for the reaction of gas evolution was done by holding a piece of moist red litmus paper over the heated test tube. B. Alcoholysis: Schotten-Baumann Reaction

A mixture of 10 drops of acetic acid, 1mlethanol and 5 drops of conc. was warmedover a water bath for 2 minutes. The odor of theester formed was noted. Abstract Carboxylic acids are mainly organic compounds containing at least one carboxyl group. Its general formulais represented by the formula R-COOH. Its derivatives, on the other hand, is defined as organic compoundscontaining a carbonyl group with an electronegative atom (oxygen, nitrogen or halogen) attached to thecarbonyl carbon. Among these carboxylic acid derivatives, acyl halides are the most reactive and amidesthe least.

Reactions of carboxylic acides also yield esters, salts and acyl chlorides. The experiment done isto test whether the substance is positive for carboxylic acid and derivatives. The reagents used are acylchloride representing acyl halides; acetic anhydride representing acid anhydrides; ethyl acetaterepresenting esters and acetanamide and benzamide representing amides. Specific tests were performed tospecific compounds. Yielding a positive results indicate the presence of the carboxylic acid group. In another test tube, a mixture of 0. 5mlethanol, 1ml water, and 0. 2ml of acyl halide oracid anhydride was prepared. ml of 20% NaOHsolution was then added. The test tube wascovered with paraffin wax and was shook forseveral minutes. An odor of the formed ester anda formation of two layers were noted. C. Aminolysis: Anilide Formation A few drops of acetyl chloride or aceticanhydride was added to 0. 5ml of aniline. Themixture was transferred to a new test tubecontaining 5ml water. The formation of aprecipitate was noted. D. Hydroxamic Acid Test The preliminary test was done by mixing

2drops of the sample, 1 ml of 95% ethanol and 1MHCL. A drop of 5% FeCl 3 solution was added tothe mixture and the color produced was noted.

If a color other than yellow was obtained, the testcannot be used. Otherwise, another test wasconducted as follows: 2 drops of the sample was added to 2ml of alcoholic NH 2 OHHCL and 1ml of KOH. Thesolution was heated in a boiling water bath for 2minutes. The mixture was cooled. 1ml of %5FeCl 3 was then added. A deep burgundyprecipitate was observed. Results and Discussions A. Hydrolysis of Acid Derivatives With the addition of AgNO 3 to acetyl chloride, awhite precipitate was formed and there was noevolution of gas. For acetic anhydride, there wasno precipitate but there was an evolution of gas.

With ethyl acetate, an alcoholic scent wasobserved when added with NaOH and then theodor was gone when neutralized with HCL. Forbenzamide, in the addition of NaOH and when themixture was heated, an evolution of gas wasnoted and the red litmus paper tested turned toblue, indicating that it was a basic solution. B. Alcoholysis: Schotten-Baumann Reaction When 0. 5ml of ethanol, 1ml of water and 0. 2mlof acetyl chloride was prepared, with the additionof 20% NaOH solution, a fruity odor and asolution with layers was noted. C. Aminolysis: Anilide Formation When0. ml of aniline was added to the sample, a white crystalline precipitate was observed, indicating the presence of acetanilide. D. Hydroxamic Acid Test The preliminary test was no longer performedbecause the reagents used in this experimentwere already given. Doing a preliminary test willsurely yield a positive result for the two reagents. For the actual test, both ethyl acetate andacetamide yielded a deep burgundy precipitatewhich was an indication of a positive result. As

said, carboxylic acids and derivatives, whenreacted with a nucleophile, the reaction is termedas nucleophilic acyl substitution reaction.

It issimilar with the reaction of aldehydes andketones but their difference is that in theproduct. An intermediate product normally formsand it expels one of its substituents originallybonded with the carbonyl carbon, leading to anew carbonyl compound. The usual nucleophilic acyl substitution reactionbegins with the addition of a polar bond to givean intermediate, the alkoxide ion. Theintermediate formed is protonated to give analcohol. In carboxylic acid derivatives, theintermediate forms expels a living group to give anew carbonyl compound.

These differentbehaviors towards the reactions are because of the difference in structure. Carboxylic acidderivatives have an acyl carbon bonded to agroup –Y that can leave as a stable anion. Whenthe addition of nucleophile occurs, the groupleaves and a new carbonyl compound is formed. The difference of carboxylic acid derivativesubstitution and aldehyde addition is thataldehydes don’t have leaving groups, therefore, no substitution takes place but only addition. The rate of the overall reaction involves theaddition step and the elimination step.

But theaddition step is usually the rate determining step. The more the electron poor the C= O is, themore readily it reacts with nucleophiles. Havingsaid this, usually acid chlorides are the mostreactive compounds because of itselectronegative ion, chlorine. Amides, on theother hand are the least reactive compound. These differences in reactivity usually result tothe conversion of a more reactive acid into a lessreactive one. Reactions

involving carboxylic acid derivativesinclude hydrolysis, alcoholysis, aminolysis, reduction and Grignard reaction.

Hydrolysis is the addition of water to formcarboxylic acids. This is seen in the reaction: There is an intermediate product in whichundergoes loss of HCL to yield the product. Thisis seen in esters, amides and acid chlorides. Alcoholysis is the reaction with an alcohol toyield amides. This is seen in acyl chloridereactions. The best known method istheSchotten-Baumann reaction, which involvesconversion of the acid to theacid chlorides: Aminolysis is the reaction of amines to yieldamides. The amine used in the experiment isaniline and the product formed was anilide.

Thereaction is as follows: Reduction is the reaction with hydride reducingagent to yield an alcohol. Esters are usuallyinvolved here which has a primary alcohol as aproduct. The reaction is as follows: Gringard reaction is the reaction of anorganomagnesium reagent to yield an alcohol. Esters are also the ones involved here convertingthem into tertiary alcohols. The reaction is asfollows: These are the reactions involve in theexperiments for the classification of carboxylicacids and derivatives. Positive observations inthese tests are usually in the form of precipitates.

Some exhibit evolution of gas. Refferences Bayquen A. V. , Cruz C. , De Guia R. , LampaF. , Pena G. , Sarile A. , Torres P. (2008) Laboratory Manual in Organic Chemistry. Manila Philippines: USTPublishing House. McMurry J. (2010) Foundations of Organic Chemistry. Cengage Learning Asia Pte. Ltd. Pavia D. L. , Lampman G. M. , Kriz G. S. , (2005) Intriduction to Oragnic Laboratory Techniques, A Small Scale Approach. 2 nd ed. Australis:

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