

so myself from iit gawhati i welcome you all to iit paul program in this class we

will study about carboxylic acids carboxylic acids are organic compounds that contain c-o-o-h functional group

so they can be aliphatic and aromatic examples if you look at it the carboxyl carbon right we can write like this

so the the corpuscle carbon is bonded with alkyl group for example methyl group is example for aliphatic in this case is bonded with aryl

group therefore is called aromatic capacity acid large number of carboxylic acid are abundant in nature and carboxylic acids that contain c12c18 carbon atoms are called fatty acids these are long chain carboxylic acids and they are obtained by hydrolysis of animal fats and oils therefore they are called fatty acids carbohydrates also serve as precursor to make acid anhydrides acid chloride amide and esters now let us look at the normal

cluster of carboxylic acids in common system the copacilic acid names are derived from latin or greek words that indicates the source of carboxylic acid for example formic acid this is the first member first of this series of carboxylic acids and this latin is formica that means and and next is acetic acid in latin a stem that means vinegar in simple copper slick acid better known by common names the names are derived from greek or latin words that indicate the source natural source of the capacity acid these are the two examples you can go like that and they do not have any general rule but however

if you look at it first one is formic acid and acetic acid if you look at it for me i see all

uh common names and they end with icy acid acetic acid formic acid propionic acid ic acid and butyric acid

so if you look at all the names ends with ic and acid formic acid acetic acid propionic acid and butyric acid these

are examples for mono capacity acids there are also die copper slick as for example this is known as oxalic acid melanic acid look at it at the end with um icy acid and these

are examples for aliphatic like composite acids for aromatic opacity acids this is known as benzaic acid this is known as phenyl acetic acid this diabol copper slick acid

is known as phthalic acid

so these are the examples for ah aromatic capacity acid these are the common names and if you look at all the acids as i mentioned earlier cn smith ic acid

so now let us look at the iupac system in iopac system carboxylic acids are called alkanic acid and for example just we have seen

so common name of this is formic acid this uh just we have seen name of this capacity cases formic acid common name the iupac name is methanoic acid the corresponding alkene is methane the e has been replaced by oic acid so this is called alkanic acid and this is name of the alkene is methane and e has been replaced by ah suffix oic and acid this is called methanoic acid and similarly this is known as ethanoic acid ethanoic acid the corresponding alkene is ethane you can see here the e has been replaced by by y ic acid and propionic acid basically the naughi pack system the names of copper slick acids have been derived from the corresponding alkanes by replacing the suffix e with oic acid and these are examples

for aliphatic capacity acids now let us see few examples for dicaprosilic acid just we have seen name of this

uh dicaprosic acid as oxalic acid and the common system impact name of this is ethane dioic acid you can see here ethane is there and i have added dye and oe acid and similarly this one

so this is known as ah propane dioic acid these are the examples for aliphatic dicapolic acids

so now let us look at examples

for aromatic opacic acids this is no ah no epact system is known as benzene carboxylic acids benzoic acid also is used naive back system

so both can be used for this

copperclick acid and the next example is ah this io pack name of this carboxylic acid is two phenyl ethanoic acid just we have seen and if you have  $\text{CH}_3$  ethanoic acid and the and second carbon is now substituted with phenyl group therefore two phenyl ethanoic acid and the effect name of this dicarboxylic acid is benzene one two dicaprosic acid just we have seen a few examples for aliphatic

and aromatic capacity acids and if you look at in iupac system their names are derived from

the corresponding alkanes by replacing the e suffix e with oic acid and all the cases you can see here and this all are simple carboxylic acids let us look at now one longer chain carboxylic acid we have to find out the longest chain that contain

the copper slick acid functional group this is the longest chain and once you find it out we have

to start numbering from the copper like acid

so then ah we have to combine the the name name and portion of the substituent

with the name of the capacity acid in this case we have a substitution at four and five

carbon atoms therefore four comma five dimethyl heptanoic acid the impact name of this copper silica acid is there and

so four comma phi dimethyl heptanoic acid we can name like this any carboxylic

acid we can name by numbering and placing the the position as well as substitution name before the as prefix to the copacelic acid and this is the how do you name for uh long chain coposic acid just we have seen the normal cluster

of carboxylic acids now let us look at the structure of carboxylic acid the carboxyl carbon exhibit lower electrophilicity compared to the carbonyl carbon this is because of the following possible resonance structures

so because of the possibility of the following resonance structures a carboxyl carbon is yellow less electrophilic nature compared to the carbonyl carbon now let us look at the

preparation of carboxylic acids the first example is oxidation of alcohol to capacity acid alcohols can be readily oxidized to copper slick acid via aldehyde using  $\text{KMnO}_4$  in neutral acidic or basic medium we can also use potassium dichromate  $\text{K}_2\text{Cr}_2\text{O}_7$  or chromium trioxide

so this

so this usually carried out in acidic medium

so you can also use potassium diagramate carbon

dioxide acetic medium that can also oxidize alcohol through aldehyde then further oxidation to capacity acid now let us see one example for example if you take propanol and when you treat with chromium trioxide  $\text{Cr}_2\text{O}_3$  in acidic medium it can oxidize to all the height so this can be further oxidized to carboxylic acid so this is known as Jones reagent so when you dissolve chromium dioxide in sulfuric acid a dilute condition this called chromium this Jones reagent this is widely used for the oxidation of alcohol to capacity acids and so this reaction usually carried out in a stone as solvent let us see the mechanism of this reaction can undergo one to addition here to this intermediate once you form this intermediate water can remove this hydrogen a from this intermediate this so this  $\text{O}^-$  you produce from this can react with hydronium ion to produce water molecule now this is called chromic chromate ester so this water molecule act as a base this can remove this hydrogen that can lead to the formation of the aldehyde you form this aldehyde plus you form this  $\text{Cr}^6+$  species this can now this can react this is known as chromate ester that now this water molecule can react remove this hydrogen and you form aldehyde plus this chromium species hydronium ion this can transform into chromium four species so if you look at it this is a chromium six this chrome chromic acid reacts with the alcohol and you generate the ester that ester transform into aldehyde and where you generate the chromium four species see a two electron oxidation process the chromium six is reduced to chromium four and your alcohol is oxidized to aldehyde once you form the aldehyde the aldehyde again can react since the reaction is performed in acidic medium it can react with the acid with water can form a acetal that acetal again can react with this chromic acid it can go on like this then you will end up with the carboxylic acid how the oxidation reaction takes place the next reaction is oxidation of alkyl benzene for example methyl benzene or ethyl benzene it can be oxidized to benzoic acid irrespective of the substituent whether methyl group ethyl group they can be oxidized the side chain can be oxidized to benzoic acid and this reaction can be carried out using chromophore the presence of potassium hydroxide first it is converted into the carboxylate when you do the work up get benzoic acid so far we have seen two oxidation reactions only the oxidation of alcohol to carboxylic acid via aldehyde first um converted to aldehyde that aldehyde undergoes further oxidation to carboxylic acid next we have seen the oxidation of alkyl benzene to benzoic acid this is very very important reaction and the alkyl chain whether its methyl ethyl or other alkyl group they can be oxidized to the corresponding capacity acid benzoic acid the next example is reaction

from alkyl halide for example if you have  
so this alkyl bromide this  
alkyl bromide can react with sodium cyanide to give the corresponding nitrile  
plus sodium bromide you see a nuclear substitution reaction  
once form the nitrile the nitrile can be transformed to the corresponding amide  
by hydrolysis when you react with it can be transformed to the corresponding  
amide that can further undergo reaction we give carboxylic acid  
so this if you have alkyl halide the  
alkyl halide can be transformed to the corresponding carboxylic acid what  
we do here we add one carbon extra here if you look at it we add one carbon  
extra that comes from the cyan cyanide the other example is this is the one of  
the  
reaction how you can transform alkyl halide to the carboxylic acid and the  
other example is you can  
also react the alkyl halide with the magnesium  
so the magnesium insertion takes place to get this is known as grignard reagent  
and magnesium zero  
the insertion takes place you get the magnesium bromide alkyl magnesium  
bromide and once you form  
this one you can react with the carbon dioxide and this reaction usually carried  
out  
in dry condition in diethyl ether or thf then the addition takes place to give  
this intermediate once you form this one this can be converted into carboxylic  
acid if you look at it we have started  
with alkyl halide having three carbon atoms we can end up with carboxylic  
acid having four carbon atoms we have one when we add one more carbon from  
the  
carbon dioxide this also very useful reaction  
so we have seen two examples under oxidation  
how you can convert alcohol to carboxylic acid by aldehyde then we haven't  
seen the  
oxidation of alkyl benzene to benzoic acid then we have seen two  
examples and reaction with al with alkyl halides and where you can convert  
the corresponding nitrile by an equilibrium substitution that nitrile can be  
transformed to the corresponding carboxylic acid  
by a hydrolysis and furthermore if you have alkyl halide that can be reacted  
with magnesium to  
form grignard reagent that grignard reagent can be reacted with the carbon  
dioxide and that can give  
the corresponding carboxylic acid with one carbon more the next example is your  
acid halide for example  
so when you treat this acid halide with water it can transform into carboxylic  
acid and similarly  
if you have anhydride this also can undergo reaction with water  
to give two molecule of carboxylic acid the other method that we use commonly  
in  
the laboratory is hydrolysis of esters for example if you have this ester and  
when you treat this  
ester with acid or base it can under hydrolysis to give it  
so similarly when you can also  
react with the base you will get carboxylic acid let us see the reaction  
pathway how the reaction takes place  
so yesterday undergoes protonation to give this intermediate  
so this is a reversible reaction

once you form this one it can react with water to give this tetragonal intermediate once you form this one this can transform to this intermediate and protonation can give this and once you form this one a so you form methanol and the carboxylic acid this is an example for ah how the hydrolysis of ester takes place to give carboxylic acid and alcohol the pressure of acid so far we have seen the preparation of copper slick acid first we have seen the oxidation of alcohol to carboxylic acid then we have seen the oxidation of alkyl benzene to benzoic acid following that we can see we saw how you can convert alkyl halide into carboxylic acids two types of reactions we have seen the first one is alkyl halide to the corresponding nitrile by nucleophilic substitution followed by hydrolysis to carboxylic acid and another example we have seen we can convert into grignard reagent that can be reacted with the carbonyl carbon dioxide to the corresponding carboxylic acid and these two examples we can have one carbon extra and then we have seen the hydrolysis of acid chloride acid anhydride to the corresponding carboxylic acid at the end we have seen hydrolysis of ester to carboxylic acid we have seen the mechanism the reaction takes place through tetrahedral intermediate physical properties copper slick acids that contain up to 9 carbon atoms are liquids at room temperature and exhibit strong water solubility so copper slick acid that contain up to 9 carbon atoms aliphatic oxalic acids that those are liquids at room temperature they exhibit strong water solubility carboxylic acids that contain more than 10 carbon atoms are generally solids at room temperature and they are generally odourless copper slick acid that contain more than 10 carbon atoms or wax like solids at room temperature they are generally waterless regarding the boiling point when you increase the molecular weight of carboxylic acid the boiling point increases and if you compare the boiling point of carboxylic acids with aldehydes ketone and alcohols carboxylic acids show higher boiling point comparing to aldehydes ketones alcohols this is because of the association of carboxylic acids via intermolecular hydrogen bonding for example if you take consider acetic acid or ethanoic acid its molecular weight is 60 the boiling point is 118 degree and if you compare with its corresponding alcohol that has a similar molecular weight is propanol so boiling point is 87 so this is because of the association of carboxylic acid via intermolecular hydrogen bonding for example acetic acid exists as a dimer even in the liquid phase or in aprotic solvent so because of this hydrogen bonding and dimeric acid so higher boiling point ah in comparison to aldehydes uh ketones alcohols for example

in this case and both this compound capacity acid alcohols have same molecular weight however

the boiling point of carboxylic acid higher than alcohols this because of intermolecular

hydrogen bonding between the carboxylic acids with respect to solubility of carboxylic acids the first four member of this series

formic acid or methanoic acid acetic acid propanoic acid and butanoic acid they are soluble in water the first four

members of this series methanoic acid ethanoic acid propionic acid butanoic acid they are soluble in water this is because of hydrogen bonding with water

so this carboxylic acids as you can see here all these carboxylic acids make hydrogen bond with water and they are soluble in water however when you increase the size of this

alkyl group when you go for C5 or C7 8 9 10 they are more hydrophobic nature they are insoluble in

water and this about the aliphatic carboxylic acids when you talk about aromatic carboxylic

acid they are whether benzoic acid or naphthoic acid they are insoluble in water okay

in summary uh today in this class we have seen the structure nomenclature preparation and

physical properties of carboxylic acids and with this we'll conclude this lecture and the part two we will study about the chemical reactions of carboxylic acids thank you