welcome to today's lecture on chemical kinetics
to remind you of what we did ah in the last   class remember we were discussing elementary
reactions
 so elementary reactions are those which   are characterized being single step in nature
and also going through a single transition state   and then we try to differentiate an elementary
reaction from a complex or composite reaction   where we said that a composite reaction is made
up of a series of steps of elementary reactions   after that we looked at the energy profile
the meaning of an energy profile both for   an elementary and a sample complex
reaction taking a specific example   from there on we moved on to molecularity where
we said molecularity is nothing but the number   of molecules based on the balanced chemical
equation that is taking part in a specific   elementary reaction molecular is only applicable
for elementary reactions please keep that in mind   and for elementary reactions the other defining
feature is that molecularity which is the number   of molecules taking part in that elementary
reaction is equal to the overall order of the   reaction the difference being that molecularity
is a theoretical quantity which by looking at   the balanced chemical equation we can determine
on the other hand order is an experimentally   determined quantity ok and hence for elementary
reactions both molecularity and order are the same   then in the last part of ah the previous
lecture we were talking about complex reactions   how do you recognize or how do you realize that
the reaction you have in hands is complex or   composite in nature
 so one of the ways of doing it
is by detection of reaction intermediates as its   written on this piece of paper well the moment
you have an intermediate what does what what   does it mean that means it is at least having two
steps that means definitely more than one step   and remember elementary reaction is a single
step nature
 so if you have more than one step   it definitely will tell you that it is a
complex reaction ok then because it is having an   intermediate one of the ways obviously of making
out whether this reaction is complex or not is   to look at the presence or look for the presence
of an intermediate but do keep in mind that while   there are intermediates which can be isolated
which can be easily looked at experimentally   many intermediates are very short lived that
means they do not exist for a long enough time   hence it might be very difficult for
us to actually look at an intermediate   just by normal experimental means we

might have
to use advanced experimental methods to figure   out whether the intermediate is really existing
or not ok
 so this was one of the ways of figuring   out whether the reaction at hand is complex or
composite in nature that is by the identification   or the existence of a reaction intermediate
the second way of doing it is by looking at   the form of the experimental rate equation which
is written at the top
 so what we are saying is   you look at the form of the experimental rate
equation thats what you are looking at and then   we showed this example
 so what is this example so
this example is the reaction between hypochlorite   c l o minus and iodide all in aqueous phases
giving as products chloride and hypoid   if if the reaction had been elementary
 so suppose
nothing is told to you about the reaction right   nothing is told to you you know you look
at this reaction to you it seems like like   simple enough reaction right and you can say
that ok then the rate should be just like   as written out here r is equal to k times the
concentration of c l minus times the concentration   of i minus now if this were an elementary reaction
that means if this reaction really was single   step in nature then this rate law is perfectly
valid why because remember by the definition of   elementary reaction i can just by looking at the
balanced chemical equation write down the rate law   right also look at the molecularity one molecule
of ah c l of minus one molecule of iodide   and look at
 so i i should not be saying one
molecule but anyway
 so now if you go to rate the   overall molecularity that is one plus one is equal
to the or the molecularity which is one of c l o   minus and one of i minus is equal to the overall
order which is one plus one equal to two
 so this   is how you characterize an elementary reaction
hence again if this reaction was really elementary   i could have said that k our rate is equal to k
times c l o minus times i minus the concentrations   of these now remember this is a theoretical one
that means if this reaction had been elementary i   can write in this form now let us do an experiment
and try to figure out what the experimental   rate law is in the real world
 so then after
doing the experimentation this is what we get
 so the rate law is actually or the rate
expression is actually given by this   equation where r the rate is equal to k the rate
constant times the concentration of c l minus the   concentration of i minus

over the concentration
of o h minus now what you immediately realize is   if this had been elementary then this is what you
had said in the last piece of paper but now you   see there is o h minus coming in o h minus did
not figure in the stoichiometry of our reaction
 so this immediately tells you this immediately
tells you that the reaction is composite   or complex in nature
 so that is why the name
of this section or this part how you determine   whether a reaction is complex or not by looking
at the form of this experimental rate equation
 so you had thought that if this were elementary
this would be the rate law but then experimentally   the rate law that was determined was this which
is different from what you would expect if it   wore an elementary reaction hence the reaction is
composite or complex in nature
 so because this o h   minus which is coming in this rate equation
was nowhere there in the stoichiometry of   the equation now let us take another example
say for example
 so we have this equation two c two plus in aqueous phase plus h two gas giving
you two cu plus equals plus two h plus equals now the observed rate law
the experimentally observed rate law
 so the experimentally observed rate
law is given like this r is equal to k times concentration of co2 plus
squared times the concentration of   h2 over k prime concentration of cu two plus plus
k double prime concentration of h plus ok where where k k prime k double prime
are all constants right now this is the experimentally
observed
 so remember this rate law is the one which we have observed experimentally
 so this expression is
obtained from carrying out experiments   now had the reaction been elementary right had the
reaction elementary what would the or what would   the rate expression be
 so the red expression
had it been elementary can be written as r is equal to
 so now look at this equation
so r is equal to k or rate constant then c u two plus squared times h two had had the reaction
will elementary right
 so we can   write this rate expression straight away from the balanced chemical equation
 so this is i can say   that had the reaction been elementary
 so had the reaction bean and elementary reaction but clearly it is not
 so why because the observed
rate law again the observed rate law which is this   the observed rate law which is this is clearly
different from the one you would have expected   had the reaction been elementary in nature so
again the form of the rate expression tells you   immediately whether the reaction is elementary

or not because elementary reactions the rate loss   or the rate expressions can be written
directly from the balanced chemical equation   however when you do experiments you might end up
having a different rate law and if the rate law   is different from the one you are expecting from
being in elementary reaction then you immediately   understand immediately understand that this is
a composite reaction
 so now you can say then the reaction is a composite reaction or one having a complex mechanism now
suppose let us you know let us take another or let   us have another way of looking at it since you are
dealing with an elementary reaction and you have   written the rate law based on your thought
that this reaction might be an elementary one   what would tell you from this rate law if
the reaction had been elementary one that   this actually might not be an elementary reaction
this is a composite reaction i will reframe my   question right let me repeat my question again
probably i was not clear what i wanted to say   was that looking at this rate law which you have
written down or the rate expression which you have   written down by supposing that the reaction went
in an elementary form that is through single step   single transition step would you be right or would
you be correct in writing this elementary reaction your your initial thought would be no and this is
the reason why
 so remember in elementary reaction   molecularity and overall order are the
same ok ok now going back to this equation   how many molecules are you talking about two c o
two plus or how many species two of c o two plus   and one of h two
 so that means had
the reaction been an elementary one   had the reaction been an elementary one i
would have said that this is a term molecular reaction where i have two species
of c o two plus reacting with one of h two but see unimolecular reactions
are ok because i have only one molecule   bimolecular reactions are still ok because i have
two molecules which have to collide simultaneously   but think about a term molecular reaction above
for us it is very hard to imagine that at the same   time all the three molecules will collide to give
rise to your product which means if this had been   a single step reaction if this had been a single
step reaction then three species one co two plus another co two plus and h two
all these three all these three would have to collide simultaneously would have to collide simultaneously
 so that the reaction is single step in nature and the moment the reaction is single step
it means its an elementary reaction but for term   molecular reactions and above it is very difficult
to have all the three species or all the three   molecules collide at the same

time it is not that
thermonuclear reactions do not exist yes they do   exist but then you hopefully you understand by now
that for unimolecular reaction we have collisions   between the same molecules for bimolecular
reactions we have collisions between two molecules   have to collide at the same time for a single
step reaction for the reaction being elementary   while we go for term molecular higher molecular
reactions it is very difficult to conceive the   fact that all the three molecules will be coming
together and colliding at the same time hence   the probability the probability of term molecular
reactions and above that means the probability of   three molecules or more colliding at
the same time to go through a single   step reaction give rise to your products
decreases and hence just by looking at   the form of this reaction just by looking
at this reaction and just by thinking about   the reaction in terms of an elementary
rate law it gives you an idea or it gives   you a hint that maybe without knowing
anything even that may be the reaction   is not elementary in nature there is a good
chance that the reaction can be a composite   or complex one involving multiple steps at
least more than one step
 so again the rate law   or the experimental determined rate
expression gives you loads of information   not only in terms of what or how the rate
depends upon the respective concentrations   but also tells you also tells you whether whether
my reaction is supposed to be a single step one   or it would rather take place in multiple steps
so this is one of the best ways of figuring out   whether the reaction you are considering or the
one in your hands is composite or elementary in   nature
 so please keep this in mind one was the
detection of the reaction intermediates and   the second one was by looking at the rate law
now for example let us take another you know another thing another example
so let's go for this example now we have already considered two examples
so this would be a third example
 so third example is ah this equation two n two o five right giving you four n o two plus o two right now the experimental determinant rate
law for this one goes like this r is equal to k times n2o5
 so this is this is experimental right but had had the reaction been elementary nature
 so r would have been equal to k in two   o five raised to the bar two
 so that is the
overall order two is equal to the molecularity   of the reaction which we get from the balanced
form of the equation
 so this is when we say that if it had been an elementary reaction which

immediately
tells you then that this reaction is a composite or complex reaction
so like this many examples can be given but   the idea was for you to be able to figure out
whether the reaction given in front of you is   supposed to be a complex one that is involving
a series of elementary steps or is supposed to   be a single step reaction which then it would
be referred to as a as an elementary reaction   where the order of the reaction is equal
to the molecularity of the reaction ok now let us talk about something which is also very
fundamental to this reaction mechanism its called rate limiting step or rate determining step ok
 so this concept again   is a fundamental and central importance
in case of reaction mechanisms will soon figure out what we mean by this suppose we consider a series
of elementary reactions   what are the reactions like say the reactions are a going to x this is an elementary reaction say
step one of a reaction and say this is the   rate constant or you know the rate of this is r is
equal to say this is the rate constant is k_1 k_1 times a next x goes to y the rate constant
for this transformation is k two   and this reaction again being elementary is equal
to r given as this and finally we have y going to   p where p is the product this is k_3 and
 so this
is r_1 this is r_2 this is r_3 we say this is k_3 times the concentration of y ok
 so each
of these steps or each of these reactions   is an elementary reaction now when i add these up
 so when i add these up when i add all these up   you can see x and x would cancel out y and y
would cancel out
 so i will be left with the actual equation a going to t now this
is the question you are asking if this   conversion from a to p or reaction from a going to
p is definitely composited in nature because it is   constituted of three distinct elementary
reactions now each elementary reaction is   given by the corresponding rate expression r one r
two r three each elementary reaction a going to x   x going to y y going to p they are having
different rates and even before that you   realize that x and y are intermediates because
they finally do not appear in the balanced   equation now as i was saying before each each of
these each of these
 so let me write it here see each step has its own right each elementary reaction
that means each step each step being an   elementary reaction has its own rate

so the
next question that comes to mind is really   if my composite reaction or
my complex reaction mechanism   is composed of three such elementary steps and
each elementary step is having its own rate then what will my final rate equ or
you know rate
of the equation a going to p or the reaction a   going to be depend upon it can
depend upon
a go into x it can depend upon x going to y   it can depend upon y going to p
right
 so the
question again you are asking is if i am having   a series of consecutive steps
which leads to
my final equation a going to p how would i know   how would i know on what my
rate of this
conversion from a to p will be based on why   because suppose you are going to
follow your
reaction by looking at the product p right   then the formation of product p is
going to depend
upon y
 so the formation of y is going to depend   upon x and the formation of x is
going to depend
upon a
 so you know keeping this thing in mind if if you were trying to analyze the
reaction by looking at the formation of the product p of p it would be difficult
and complex why because the formation of p depends on y now the formation of y
depends on the formation
of x and the formation of x   now depends on a right
 so p depends upon y you see
p is depending upon y then i said y depends upon x   see y is not depending upon
the
formation of x similarly x will depend   upon how it is found from a hence t is
depend upon y which in turn is dependent   on x which channel is dependent upon
a this tells you that this is quite a complicated   it's quite a complicated
picture ok
 so this you
should be as complicated
 so let me write it again   this is quite a complicated picture but see
you also know you also know that many rate laws or many rate expressions are
quite simple quite simple then then the question is how do we decide on which
step the rate of reaction will depend upon because
in these three consecutive reactions   which have their own rates you do not
know how each of these contribute to the   final equation which is a going to p
but that
as i said though it is complicated many rare   expressions are quite simple for
you to deal
with thus there must be a proper way of deciding   that ok this step may be step
one or step two or
step three will tell you or will finally determine   the overall rate of this
transformation of
a going to p
 so lets now think about this   in a little ah different manner so
how ah do we you know think about this suppose one day you have to go to a
friends
place from your house right and then you have   to traverse a road you go

through a road say you
are taking your car or you are going uh you're traveling in a bus or you're travelling in some
other mode of communication mode of transport let's consider that this is your home right and say this is your friend zone right
 so you have to go from here to
here now as it happens one of the ways or one of the parts will go
like this suppose from here you have a very broad road ok then in between for some reason the road becomes very
narrow for ah say a certain stretch say one or two kilometers and then again it widens up and your friends home is somewhere here ok
 so just
take this as a sample road trip you are taking from your home to your friends house or friends
place now see if you are starting from here since the road is wide enough in this stretch then you
will see the cards will travel pretty fast right there will travel very fast but the problem
is the moment they come to this this place the moment they come to this place here a different
thing happens now the cards have to slow down why because initially the road was pretty wide
broad the width of the road was big enough but that many cars could go side by side at a decent
speed but the moment the road narrows out here the moment there are narrows
out here see what happens you see it has become very narrow see at this
stretch only cars in one line can go through after that again it starts widening out hence the cars can again maintain
their speeds ok now lets think about this in terms of your chemical reaction suppose this
is step one right suppose this is step one ok suppose this is step one
this is step two and this is step three it is very visible from this example that in steps one and three the cars would be
travelling at a very good speed say high speed but the moment you come to step two the moment
you come to step two what has happened is the cards had to slow down they had to slow
down they had no other option because there was no road the road available was very narrow
 so the
total time they took that means the rate at which you could leave your home and go to and reach your
friends place was not determined by steps one and two but it was determined by step ah sorry it was
not determined by steps one and three but it was determined by step two because this is the part
which was the slowest stretch in terms of travel from your home to your friends place
 so we say
that if this you know if this is the slowest step then slowest i mean slowest step
then this is also referred to as the rate determining step or rate limiting step the other way of looking
at it is or you know the other commonly used word for this one is called a

bottle neck why is it called a bottleneck
 so if you do not
look at this if you think about this with the   bottom it looks like a bottle
isn't it so
in you know what happens in a bottle there   is a white base cylindrical going
like this and
then at the top the bottle becomes narrow right
 so you have a white base like this then the
bottle is a cylindrical and then out at the   top it narrows down it tapers down
that is the
neck of the bottle and that is why it is called   the bottle neck
 so the bottle neck wherever you
face a bottleneck this bottleneck is a slow step   right this bottleneck being
the slowest step
it determines at which rate you are going to go   from this place to the other
place which is your
friends place or in terms of a chemical reaction   if i have three distinct
steps steps one two and
three then the slowest step which in this case   say step two would finally
determine which at
what rate the reaction would be moving from the   reactant side to the product
side it does not
matter at all how fast steps one and three are   it does not matter why because
these are very
fast anyway where do i face the bottleneck i face   the bottleneck in step two
 so wherever have your
bottleneck that means whichever step is the bottom   leg that means whichever
step is the slowest step
in a series of consecutive steps would give me the   rate of the reaction or the
rate of your road trip
in this case the other steps do not matter at all
 so this is extremely important in terms of the
reaction mechanism because when you have again   many many steps and you are
trying to figure
out what would the rate depend upon or what   would the actual rate be then you
would soon
realize that because my rate depends upon the   bottle next step that means the
step which is
the slowest one
 so my rate expression my rate   expression would also be determined by the
slowest
step and not by any of the other steps which are   faster than this slower one
ok
 so hopefully
i have been able to impress upon you what our   rate determining step means the
rate remaining
step is the one which poses the bottleneck the   bottleneck is the place where
the rate is the
slowest and because the rate is sliced out here   this is the one i repeat this
is the one which
determines the final rate of your reaction going   from a to p
 so this is extremely important
to remember right
 so now going back to our   series of ah you know elementary steps here say

if i go back to the series of elementary steps   right i do not know now which one is the
determining step now suppose i tell you that fine   let the rate determining step be the first one

the rate determining step is the first one in the
series of reactions then it immediately falls out   that for the series of reactions finally
a going to p that means i have a going   to p which is made up of these three steps
elementary steps then the rate is equal to k 1 times concentration of a because
because the step a going to x was the slowest step or the rate determining step
and let me also write this here it does not matter how fast it does not matter how fast the other
steps are
 so step one of the reaction is the   slowest one the other two are faster than this
hence the rate of the reaction is decided by this   step only the other two steps do not matter at all
i hope been able to make myself clear in terms of   what would finally determine the rate of a
reaction especially in case of a multi step   process or a complex reaction as written
out here and again i can then write if if the first step is the rate determining step sorry determining if the
first step is the rate determining step then then the rate of the overall reaction will only depend on the first step
 so this is important if if the
first step is the rate determining step   ok then the rate of reaction will only depend on the first step the other two steps in this case
no matter how fast they are will not matter at all
 so as usual lets take an example
 so let us have this three c l o minus going to c l o three minus   equals phase plus two c l minus
aqueous ok that the proposed the proposed reaction mechanism goes like this goes like
this that c l o minus plus c l o minus me c l o two minus plus c l minus
then c l o two minus plus c l o minus   gives me c l o three minus plus c l minus ok again
you cross check cl o two minus is intermediate
 so if you add these two reactions you should be
given getting back the balanced chemical equation   right
 so this is the proposed reaction mechanism
right
 so this what is very important this is the   proposed reaction mechanics if step one   is right limiting that means this is step one
if step one is rate limiting ok then i can write for step one being the rate limiting step or the rate determining step
 so this was step one then r would be k c l o
minus c l o minus or r is k c l o minus square   ok if the first step is the rate
limiting one now indeed indeed   the experimentally observed one
 so r
experimental is equal to k c l o minus   square

so what does this tell you
so what it
tells you that whatever equation we observed   experimentally and the proposed reaction mechanism
the reaction mechanism is a plausible one   because why is it plausible the reaction mechanism is plausible   or the proposed means its plausible
so i can say this a plausible reaction mechanism why do we say
so because if this war if
you know this what the rate limiting step   if this was the rate limiting step then the r
would have been predicted to be k times clo minus   square right this being in elementary step overall
order is equal to the molecule or the reaction   also from experiment we get the same rate
expression hence i repeat hence the word plausible   that means whatever reaction mechanism is
plausible because the rate expression we predict   from the steps of the reaction mechanism does
follow the one which is observed experimentally   as given here let us do another
example real quick since we are on this two n o two gas plus f two
gas gives me two n o two f   gas right ok experimentally experimentally so
let me write r experimental is k n o two times   concentration of f two so
this is r experimental right   now what about the proposed reaction mechanism
so the proposed mechanism goes like this n o two plus f two gives me n o two plus
f then n o two plus f gives me n o two   f i should be writing another f out here
so there
are two steps to this reaction the first step is   n o two plus f two giving me n o two f plus f then
n o two plus f giving me n o two f the first check   is you add these two up you add these two up
what you see is you get two n r two plus f two   giving you two n r two f right
so hence when i add
this up i get back the balanced chemical equation   now you are also the proposed mechanism
you are saying that this is the slow step
so if this is a slow step if this is a slow
step then you immediately realize i can write   r is equal to k times n o two f two and the moment i have written that i see
that this form does agree with the one observed   experimentally hence the proposed mechanism
is a plausible one
so i can say this one is a plausible
so this one is a plausible plausible mechanism ok just because of the fact
that my predicted rate expression   based on the proposed mechanism does agree with
that observed experimentally
so this is important now one of the characteristic features you
have seen out here is for this reaction or   even as a matter of fact for the reaction we ah
did before which was this one which was this one   the first step the first step

was
the slow step
 so this one was a   slow step
 so the first step was the slow step
for this reaction and for this reaction again   the first step was the slow step
now just to
give an example you do not have to worry about it   would you have all reactions
where ah the first
step is or do all reactions have the first step   is a slow step not necessarily
right you know
reactions are complicated nature there are so   many reactions out there and
there will be many
reactions where the first will not be the slow   step now what do we do in that
case or you know
can we look at that in a different way how do   we write the rate law
 so let us take an example
this for you is just to understand just for you to   understand let us not go
into the details of it i
will write some of the things down but i will not   explain everything ah you
know which you will soon
see but this is for you to understand what happens   if the first step is not
the determining step
as we have been doing out here right
 so let us   take an example like that ok so
here what we say is then that the first step is not rate determining the first
step is not rate determining
that is an example we are going to   look at ok
 so suppose i have this reaction a plus b going to products   right and i am
told that a
proposed mechanism is as follows a going to x right and then b plus x going to
p
now because the first step is not radio domain   it immediately tells me that if
the first step is
not very determining and there are two steps then   the second step has to be
determining right that
means a slow step right if that is the case then my proposed rate law becomes r
is equal to say if
this is ah ok if this is you know k 1 this is k 2 k 2 times concentration of b
times concentration
of x now this is absolutely fine right my second   stage is my array determining
step and i am what
i am writing is i am writing this in terms of   the concentration of vf
concentration of x see
what is the problem like the problem is here   that the b is a reactant ok its a
reactant
good however what about x if you look at the   two steps step one and step two
then a goes to
x then b plus x going to p and then i sum it i   get a plus b going to b
 so x does not appear
out there which means x is an intermediate   now we have already discussed
before a bit
that all intermediates cannot be isolated   all individuals are not easy to
handle and
cannot be easily observed experimentally hence   it is better for us not to

write a rate
expression involving an intermediate   as much as possible we try to avoid any
indium
units in the final rate expression now how do we   do that
 so what we do is we propose a mechanism
such that this x does not feature in the   rate expression and how do we do that
 so this is
where i said i will not go into the details but i   will just show you the
example
 so that you have a
better feeling of the same
 so what we say is that   ok we will still go we will still go by this ok we
will still go by this 2 steps a going to x and b   plus a is going to be will
make a slight change
what is this change change changes as follows a goes to x and we give it an
equilibrium sign
 so what we say is that   this is k one this is k minus one and we call this
the first step as a fast as a fast pre equilibrium step ok as a fast pre
equilibrium step
then obviously the next step is what b plus x going to b and this is k
two and remember because this is the slow step or the rate determining step
or the rate determining step which many   books you will see right will write as
r
d s the rate determining step r d s then the rate law is k 2 x as you had
written in the previous
slide but is there a way to replace x   out is there a way to replace x out let
us look at this a in equilibrium with   x
 so what happens is at equilibrium if you look
at step one right
 so if this is you know step   one this is step two then i can
write from step one which is a which is a in equilibrium with x first
equilibrium   k one and k minus one
 so what is
k one k one is the rate constant   for the forward reaction k minus one is the
rate constant for the backward reaction at equilibrium remember we are
considering step one
here only at equilibrium what happens the rate of   the forward reaction is
equal to the rate of the
backward reaction isn't it
 so what is the rate of   the forward reaction
 so in both directions rates
are elementary nature i mean these are elementary   nature the reactions are ok
 so the rate of the
forward reaction is k one times concentration of a   and the rate of the
backward reaction is equal
to k minus one times concentration of x ok and   because this is
 so you see we immediately have
the expression of x or ah x written in terms of   k 1 over k minus 1 into
concentration of
a now this is an extremely important step   also also remember if this is an if
this is an
equilibrium situation if this is an equivalent   situation then i am going to
have an equilibrium
constant

so the equivalent constant can be the big k the k equilibrium constant the k equilibrium
constant from this one is what is equal to   concentration of x over concentration of a right
which is equal to k one over k minus one
 so you   see you have two forms two very interesting
forms one is this and the second one is this   now by doing this what you have done is if you go
back to a ray determining step which determined my   proposed rate law which is k two times b times
x this x had to be replaced now based on this   pre-equilibrium constitution what do i have i
have x is equal to k 1 over k minus 1 into a   then what i do is i take this and replace x by
this expression that means now now my rate becomes
 so rate was k 2 times concentration of b
times concentration of x now based on the fact   that i have x is equal to this then i can write
r is equal to k 2 times consideration of b now by   concentration of x i replace k one over k minus
one concentration of a or r is equal to then   k two k one k minus one consideration of
b concentration of a right
 so this is also k equilibrium right
 so then the
other form is that r is equal to   k two k equilibrium consideration
of a concentration of b hence i gave you an example where
the first step was not red limiting some other subsequent step was and in
that case if an intermediate is coming in   then i assume something referred to as this
fast preequilibrium and using that i replace   i replace the intermediate by something
which is in terms of reactant which you are   which is more easy to handle for
us which we can readily handle   this i did not explain too much about fast
preequilibrium but just to give you the flavor   of what types of different complex reactions can
come in different complications can come in one i   can have a fast ah you know fast ah first step
which is very determining in this case it is a   second step that means in this case the
second step but not the first step which   is very determining and then it becomes more
complicated and then say go on to give rise or   you know go on to propose a different sort of
rate or a different sort of mechanism right i   hope i have been able to ah you know impress upon
you the importance of this raid determining step   and how reaction mechanisms plausible reaction
mechanisms can be devised just some examples to ah you know to make sure that
the proposed one is   in agreement with the observed
rate expression thank you you