hello everybody welcome to the
second lecture on chemical kinetics   before i go ahead with the lecture this
time
what i will do is i will you know quickly ah do   a recap of what we did in the
previous lecture at
least some part of it because i have to continue   with i am going to continue
with certain aspects
which i did not discuss last time in detail
 so if   you would remember and if you would look at this
power point slide you know we were talking about   the introduction for chemical
kinetics and we were
discussing that you know thermodynamics does not   give you everything it tells
you that the reaction
or whatever you looking at the process is supposed   to happen but it does not
tell you or give you any
time information and that is why kinetics becomes   or plays a very major and
important role in
chemistry and in doing that we started discussing   some examples very relevant
examples and one of
the examples if you remember we took up was with   regards to the catalytic
converter present in a
car and as you can see if you would try to recall   what we had in previous
lecture
 so this slide
is showing you a catalytic converter you have
 so the first slab has rhodium as a catalyst
as written out here then the second slab has   platinum belladimos catalysts
 so the first this
you know this slab if you follow my white pointer   you know it helps in
reducing the
oxides of nitrogen to nitrogen itself   and the second one make sure that it
oxidizes
the carbon monoxide and hydrocarbons which were   not burned to carbon dioxide
and water which
are not harmful now while doing that and if i   you know if i go forward
 so this is essentially
what we are looking at
 so it says what you know   how a catalytic converter works and we you
know we were discussing at length about the   reactions involved the catalysts
what they do
and all in doing
 so what we had mentioned also   was this photochemical smog we had said that
if we do not have a catalytic converter then   the emissions coming out which
are the oxides
of nitrogen carbon monoxide unburnt hydrocarbons   then they start polluting the
atmosphere
giving rise to air pollution as we know   now we also said that this
photochemical smog
is a typical feature where the pollution is   not controlled you know we have a
huge number of
automobiles plying each and every day then i ah   you know also told you if you
remember at the time
that will come back to this word photochemical   later why it is called
photochemical but in

that lecture we do not have the time
 so what   i will do is i will you know in continuation
with that lecture and what we had discussed   i will spend some time on this photo chemical
smog issue and then move further on with chemical   kinetics
 so with regards to the photochemical smog
and as you would realize the word photochemical   if you you know talk about this word photochemical and if you spread it up it
will split up into two things   photo means coming from photons
which is light and then chemical we are talking about a chemical process or
a chemical reaction which means that when we   say photochemical smog we are talking about a
reaction or a set of reactions which is induced   by light or photons ok now you know
typically when you look at this ah   smog when you look at this mog this
photochemical smog it has a brown brownish   tinge or haze then the question is where does this
color come from
 so let us look at that this color   this color in the smog comes from a key
ingredient in the smog a key ingredient   in the smog and that cream ingredient is
nitrogen dioxide
 so nitrogen dioxide it absorbs visible light it absorbs visible light
you know light we can see we can visualize
 so on absorbing what happens is if i have n o
two out here which we are talking about then   i represent the photons as h nu where h is
the planck's constant nu is the frequency   you all know about it then for a
frequency of about 400 nanometer or less   if enough molecules are being hit by light of this
wavelength or lesser that means four nanometer or   lesser then what we end up getting in terms
of the reaction is n o plus o ok let this be   our reaction one
 so we are getting nitric
oxide plus oxygen now the oxygen atoms   obviously are very reactive
 so what will
happen is the oxygen atoms react immediately
 so o three plus o
 so oxygen atoms react
immediately with just make this correction   this is oxygen of the atmosphere o two
 so o
two plus o will be giving rise to o three ozone   and you know that this ozone is being produced
out here from the oxygen atom which was coming   from the splitting of nitrogen ox dioxide into n
o and o photochemically and this oxygen or this   oxygen atom combines with o two to give us ozone
right now remember we are talked about in complete   combustion also
 so incomplete combustion
means that we have some un burned hydrocarbons
 so when we have unburnt hydrocarbons if you
represent it as the unbound hydrocarbons as   r h then what we can say is happening

is that r h can react with this hydroxyl radical i will tell you where this
hydroxyl radical is coming from to give r dot plus h two o
 so let this be equation three
and this becomes equation two
 so once
 so here you   see we have the production of ozone right then we
have this incomplete combustion because of which   we have these hydrocarbons
which were not
burnt which passed through to the atmosphere   and this r h then combines with
or reacts
with the hydroxyl radicals in the atmosphere   to give rise to this r dot
radical plus
h two o now what happens to this r dot
 so r dot now goes ahead and reacts with the
oxygen of the atmosphere to give rise to r o   o dot now this r o dot let this
be reactionary
equation four now r o dot you immediately realize is a per oxy radical like
hydrogen peroxide we
have this o peroxy bond
 so this is a peroxide   radical now in this peroxy radical the o
o bond is not that strong
 so the o o bond   bond in r o o dot is weak in nature
 so then
what would happen is this weakened o bond   can readily this we can o bond can
readily donate
an oxy an oxygen atom
 so like this
 so i can have   r o o dot right it then reacts with n o to give
me
 so it is donating an oxygen atom now to give me   r o dot plus then n o two ok
 so let this be
equation five
 so see where we started from we   start from what the spreading of n o two to
n
o and o this o reacted with oxygen to give me   ozone then we went on to unburnt
hydrocarbons
represented by r h which reacts with hydroxyl   radicals if you remember r h
plus o h
dot gives you r dot plus h two o now this   radical this hydrocarbon radical now
reacts
with oxygen of the atmosphere to give us a   peroxide radical r o o dot this
proxy radical has
a weak o bond hence this bond can be easily broken
 so the peroxy radical what it
does is it donates an oxygen atom   to n o via this reaction giving rise to r o
dot
plus n o two what other reactions can take place
 so again keeping in mind the fact that this
you know this hydrocarbon having reacted with   o h dot you must be wondering
where this o h
dot is coming from
 so let us see that
 so the   o h dot comes from this equation
 so now what

we are trying to look at is how do the o h radicals come about or come into existence
 so here   remember there is ozone which we had looked at
right
 so ozone
 so it is oxygen combining with o   coming from n o two to give you ozone see ozone in
presence of light again photons you know less than   say three twenty five nanometers
 so photons having
wavelength of three twenty five nanometer or less when they fall on ozone this is what happens you
get oxygen plus o star
 so let this be equation six   what is o star
 so o star
 so star means excited
state
 so all of you must be knowing that you   know you have ground states excited states
and
 so on
 so this o star represents the oxygen   atom in the excited state now it goes without saying that because
it is in the excited state it is having a lot   of energy and at the first available opportunity
it will try to get rid of this energy that means   it will try to react with something how does it do
it or what reaction does have ah does happen after   this
 so what happens now is because you have water
vapor in the atmosphere this o star now reacts   with water to give you two o h radicals let this
equation seven hopefully now you will realize   why in case of that hydrocarbon reaction r h the
unspent or unbound hydrocarbons which reacted with   o h dot to give you the corresponding radical
right r o dot ah you know
 so this r plus o h   dot when you got that you know the reaction i am
talking about is if you remember the reaction i am   talking about is this r h plus o h dot giving
r dot plus h two o
 so when we said that this   o h dot how do we you know get this y s dot this
o h dot is available or coming to us like this   now what happens to this o h dot also is that we
have n o two
 so there is another reaction plus   o h dot gives you h n o three you realize
now that this is nitric acid hence the term   acid rain n o two plus o h dot which we
saw just getting produced from this excited   oxygen atom which was obtained
from the splitting of ozone right   and this one thing i forgot to mention when you
are talking about the splitting of ozone you see   these this wavelength of if i say this wavelength
of 325 nanometers if you consider this wavelength   of three twenty five nanometers

right this we refer to as the harmful u v or ultra violet rays
 so this is in relation to your
ozone holes that means if you have arm full   ultraviolet rays and these ultraviolet lays
what they do is they split ozone up into   molecule oxygen and excited oxygen atom which
then goes on to show the other reactions now that's why you know the reason we had all this discussion
was to make the point that these reactions   would be occurring to a large extent giving
rise to air pollution if we do not take care   of the combustions in this case coming
out from the cars and we have
 so many   cars on the roads nowadays that if emission
standards are not met then the pollution level   will go up dramatically right
 so hence i think
that i have been able to make the point about   why we were discussing that the need for all you
know these equations these are you know this this   is more on the environmental chemistry side rather
than just to do with kinetics but it is extremely   important to know why the catalytic converter has
to be there what are the reactions involved what   are the catalysts involved catalyst definitely
is a part of chemical reaction it enhances or it   increases the rate of reaction by decreasing
the energy barrier which we will see later   right
 so that is why catalysts are there they make
sure that most of the harmful gases are converted   into those that are less harmful or not harmful
at all some gases do escape because maybe the   combustion or the conversion is not hundred
percent and those would go and give rise to   air pollution like all the equations we have
written out here culminating in this acid drain
 so it is extremely important that we know this
and we relate it to the need for having a cleaner   better air ok now let us move on so
we have you know we have talked about   you know we have talked and out of the introduction
 so where did you know this   all began but before ah you know going into
this chemical kinetics about the rates and all   lets talk about this
 so you might come across
something referred to as thermodynamically unstable but kinetically stable lets take an example to see what this means so
let us go to this slide on this slide what you   are seeing is the hydrolysis of atp adenosine
triphosphate now you can see this adenosine   triphosphate this is the structure of adenosine
triphosphate it is having four negative charges   right triphosphate
 so three phosphate groups if
you follow my arrow one two three phosphorous   atoms and the rest are the oxygen atoms along with
the phosphorus now what happens is hydrolysis of   atp releases a lot of energy

so if you see if
you look at this slide again what you are seeing   is that you have adenosine triphosphate adenosine
triphosphate and hydrolysis that means on reacting   with water which we call hydrolysis will give rise
to adenosine diphosphate in adenosine diphosphate   what has happened is one of the phosphate groups
has been hydrolyzed off or it has snapped out that   means it was broken off it has come out
 so you
get adenosine diphosphate adenosine diphosphate   now has three negative charges instead of four
as was there in adenosine triphosphate and now   this adenosine diphosphate having the three
negative charges along with that we have this   phosphate enumerating phosphorus which has come
out and h plus ok now if you have to write this in   in equation form the way you will write is
so as i say we were discussing the hydrolysis of atp right and in this hydrolysis of atp
what you are saying is that i have a   t b there are four negative charges
 so four minus plus h two o   we are looking at hydrolysis of atp right
having four negative charges it gives me a d p   adenosine diphosphate from try to die i
have lost one phosphate group this has   three negative charges okay plus h p o four two
minus plus h plus right this hydrolysis comes   with release of energy right and in this case you
can see out here if you go back to the slide again   you will see that the conversion of atp to adp
as illustrated ills about 7.
3 kilo calories per   mole of atp this much of energy is released when
we go from atp to adp right
 so often if you are   talking about the thermodynamic feasibility of
a reaction you talk in terms of change in free energy right change in free energy which is delta
g and in this case the change in free energy is   equal to is almost equal to minus 30.
5 kilo joules
per mole
 so that means the change in free energy   delta g in this case for the hydrolysis of atp
to adp is highly negative that means it is highly   spontaneous that is why because it is spontaneous
that is why it is often atp is referred to as the energy currency of the cell or body ok adp is often referred to as the energy currency
because it provides energy now the thing is   if it is thermodynamically feasible it might
make you think that it will always happen   just like that right that means our body
will never be able to have atp stored   because it will immediately be converted to
adp as it would seem from the thermodynamic   feasibility of the reaction

because
delta g is
 so negative but you know what
 so this is called thermodynamically
unstable which means that the atp is thermodynamically unstable right however
the point is that it can
be thermodynamically unstable but kinetically kinetically this reaction this
hydrolysis
reaction i can write the hydraulicis of a t p is very slow right hence we call
it kinetically stable which means that though its
thermodynamically very much prone to   hydrolysis but the rate of this
hydrolysis is very
very slow this is why remember when we started   this section of our discussion
we said this
there can be something which is referred to as   thermodynamically unstable but
kinetically
very stable and the hydrolysis of atp is   an example of that which brings us
to
you know the very start of introduction   there is a previous class where we are
saying the
thermodynamic tells us only over the feasibility   of a reaction if it is
negative that means
it is supposed to happen if it is positive   that means if the free energy is
positive
that means it is a non-spontaneous   process but what it does not tell us even
though say delta g is highly negative as we   saw in case of the hydrolysis of
atp what
it does not tell us is the rate at which   this reaction in this case hydrolysis
of atp is
supposed to happen and as i told you right now   this being kinetically very
slow which means
that though it is thermodynamically very feasible   kinetically it is going to
take or in terms
of time is going to take a long long time to   take place hence this reaction is
called or this
process is called thermodynamically stable i mean   the hydrolysis of atp
thermodynamically stable
or rather thermodynamically unstable i am sorry   thermodynamically unstable but
kinetically very
stable ok
 so that is why the need for kinetics   and to understand what kinetics involves
another
example is if you again here another example   you know has to deal with
graphite and diamond
graphite and diamond what they are graphite and diamond these are allotropes of
carbon now what it turns out
is graphite being more stable than diamond   what it means that since
graphite is more stable than diamond then this is i would expect that if i have
any diamond that would spontaneously convert to   graphite now think about this
then all of us would
be having diamond rings or any diamond items right   they should have
immediately converted to graphite
right but does it happen no it does not happen   again this is a case of
thermodynamically

unstable
 so i can write then diamond is thermo dynamically unstable right its thermodynamically
unstable but this reaction of this conversion   is very slow hence we say that the
process this process is kinetically quite stable this you do not have to worry
about this that diamond getting converted to   graphite it takes a long long time which
 so let
me go up if you look at the slide you can see   at the bottom this written this popular statement
diamonds are forever they indeed are forever   because though diamond is not the most stable form
graphite is hence in terms of the free energy of   conversion this process is spontaneous conversion
from diamond to graphite has delta g negative   but because kinetically the reaction goes
very slow this reaction is referred to as   kinetically being stable again or you know
makes us come back to this point again   the thermodynamic
 so only tells us about
whether the reaction is going to happen or not   it does not tell us or give us any information
about the time involved good
 so having   made ah you know these points lets now try to
go into ah the kinetics the formulations of   kinetics and
 so on now what we will start with
is you know say the birth of chemical kinetics   the birth of chemical kinetics now this goes back
to as old as 18 50 when a person called ludwig will help me did something what
did he do what he did was he followed the breakdown of cane's sugar he followed the breakdown
of cain sugar or i can write sucrose in acid solution into glucose and fructose
 so ludwig valenme was observing a process
which involves the breakdown of sucrose into   glucose and fructose now what did he find this is
what he found what he found was that will help me noted that the reaction rate at any time the reaction
rate at any given time was proportional was proportional to the amount of sucrose left
 so again think about the implications he
is saying that after the reaction started at the start of the reaction during the progress
of the reaction the rate of the reaction at any   time after the start of the reaction was
always i can say directly proportional   according to him directly proportional to
the amount of sucrose left in the reaction   mixture that is the sucrose which was
left unreacted i can write left unreacted at that time hence will help me is
often referred to as the father of chemical kinetics often referred to as the
father of chemical kinetics because of this observation of his this is or this was the birth
of chemical kinetics as we know of it right now   now since then chemical

kinetics has seen many
many levels or degrees of advancement right and   to top it off just to share this information with
you before i go into the rates and all up till now nine nobel prizes in chemistry i am sure you know
what the nobel prizes are   nine nobel prize in chemistry have been awarded to the field of chemical kinetics just wanted to share this information with you
 so you understand   how important this is how important
this is as a part of chemistry   and that is why we are here to discuss and talk about chemical kinetics ok now again going back to chemical kinetics what is it
simply put if you have a reaction you would want   to know how fast or how slow the reaction is
going that means what you are dealing with you   dealing with the rate of a chemical reaction ok
so that means you are going to follow a reaction   as a function of time
 so lets do that
 so say
we are looking at rate of a chemical reaction this is what we want to do and when we do
this what does the kinetic study involve   ah kinetic study that means
a study in chemical kinetics involves following the rate of a given reaction any
reaction you are talking about   or you are thinking about or you want to discuss as a function of time right
 so this is important as a function
of time thats why its called the rate of reaction ok thats why its called the
rate of reaction what is the time taken   for that specific reaction to proceed
in the direction which is supposed to   go now this can be done in a number of ways
right there are many many analytical techniques like many analytical techniques
exist by which we can measure by which we can measure changes in concentrations
of reactants or products sorry this would be you can write
this again reactants or products or both or both together it does not matter
because when your reaction proceeds your reactants   would slowly disappear and your products will
slowly appear both are happening as a function   of time and depending upon the reaction you are
considering both would be following a certain rate   and you can have enough information about the rate
of that chemical reaction by following either of   these or one of these now in terms of you know the
analytical techniques what i mean by that is see   when you are saying that ok this concentration
is decreasing this concentration is increasing   how do you realize that how do you realize that this realization or the way you follow the
decrease in concentration of reactants or   the increase in concentration of products is
typically done through a range of techniques   referred to as analytical techniques the
techniques involve very simply ah peaking speaking   you can monitor the ph of a reaction right you
can monitor the pressure changes in a reaction you know if your reaction is

colored that means
you have color in the reaction you can monitor   how that color changes as a
function of time so
which means
 so you know you know think about this   suppose your reactants are not colored
but your
product is colored then what you can do is you   can say that ok i would look at
the color and
i would see how the intensity of that color   is varying or changing as a
function of time right
so this color change is you know done through   spectroscopy like absorption
spectroscopy or you
can also say that ok i have a reaction where my   reactants are colored but my
products are not are
colorless my products are colorless then what you   would see is you would see
that you would start
with a reaction which is quite intensely colored and then with the progress of
the reaction as
time increases the color disappears and goes to   colorless
 so again if you would follow
this color change as a function of time   you will be having an idea of the rate
of the
reaction
 so there are many ways i am just i just   you know gave you a few examples
so the examples were like the ph change right you can consider pressure change
you can consider change in sorry this is change in color all these can be used
to follow reactions and determine reaction rates next there is a very
important point you have to keep in mind   when you do these measurements to
figure
out how the changing is happening
 so that it   leads you to the rate of that chemical reaction all these
reactions all
 so this arrow is from the
previous page all these reactions need to be carried out under isothermal
conditions all these reactions need to be carried   out under isothermal
conditions what
does isothermal mean isothermal means constant temperature this is extremely
important why is this
important because you know that the rates of   reaction are dependent on
temperature right you
increase temperature the rate of reaction will   change hence it is extremely
important for you   to make sure that the temperature is
kept constant when you are measuring the   rate of that reaction or performing
the
experiment on chemical kinetics however however if your idea or if your goal if
your goal is to measure the temperature dependence is to measure the temperature
dependence of the reaction then it is obvious that the temperature needs to be
felt
 so then what have we said   we have said some very simple but very
significant things
 so for the rate of the   chemical reaction when we said we said that when
you do a kinetic study it involves following the   rate of a given reaction as a
function of time
this is referred to as the rate of the reaction how do you measure the rate of

the reaction

so the measurement of the rate of reaction is   done by looking at changes in concentration

or changes in consideration of reactants   or changes in concentration of products or both

how do you measure these changes you measure these   changes by certain analytical techniques some

examples being say a ph change it can do through   say potentiometry pressure change if the reaction

involves changes in color then those changes   and

 so on not only that because reaction rates are

very much temperature dependent it is extremely   important that if your goal or focus is only to

measure the reaction rate not as a function of   temperature but at a certain temperature then

it is essential that isothermal conditions are   maintained however isothermal means constant

temperature that means the temperature does not   vary otherwise the rate of the reaction will

vary and you will be having erroneous results   results which are not correct or accurate however

it is obvious that if you really want to look at   the temperature dependence of a reaction then you

have no other option but to allow the temperature   to change that means you change the temperature

yourself and then you see that how the rate is   varying to clarify what i meant by allowing the

temperature to vary is that i do the same reaction   at different temperatures so what i mean by that

is suppose i have this reaction a going to p   right i want to see the temperature dependence

of the reaction and how do i do that   i say i start with an initial concentration of a

of the reactant a ok now once i start with that   what i will do is i will run several experiments

that means the same experiment as a function   of time which is the kinetics i will run how

will i run it suppose this is experiment one   and this experiment one i run at temperature

say t one then i have say experiment two and i run at temperature t two and so on

 so you have experiment three   i run which i run at temperature t

three again i have experiment four and i run it at the temperature t four so these are my temperatures

 so these are my temperatures right and what i am doing is i am

running exactly the same reaction where i start   with the same initial concentration of a ok i do

not change anything i run the experiment multiple   times but what do i do is for each and every

run say expand one which is run one the first   time i am doing the experiment say i am doing at

a temperature t one then i do the same experiment   at temperature t two again i do the same

experiment which is say experiment three now   but this remember this is the

same experiment so

what i mean is that i am just going for different   runs of the same experiment ok i am not changing

anything else i am starting with the same initial   concentration of a the only thing i am changing is

the only thing i am changing is the corresponding   temperature

 so there is experiment one or run

one is done at temperature t one experiment two   is done at temperature t two experiment three

at t three expand four at t four and

 so on

 so by   this what we do have is we have the dependence of

the rate of this reaction which is a going to be   as a function of temperature and this is what i

meant when i said the temperature dependence of   a reaction rate when it is supposed to be taken or

when it is supposed to be measured i have to vary   the temperature that means i vary the temperature

for different subsequent runs the more the number   of temperatures you have the more the number

of points you have and it is better you for   any subsequent analysis but the take home point is

that when i have to do the temperature dependence   or if i have to see the effect of temperature i

have to run the same experiment okay different   times six point one expand two exponential this

is the same experiment i am running this like   different runs of the same experiment at

different temperatures say t one t two t   three t four t five t six and

 so on depending upon

the number of points i am going to take

 so again   this is what i mean by temperature dependence

and this has to be done if you are studying   the temperature dependence of that reaction ok so

these statements you know might look very straight   forward but these are for some very significant

statements that you have to keep in mind before   you embark on actually doing an experiment related

to chemical kinetics ok now let us consider   a reaction as i said then it is time we start

going slowly in to the realm of reactions and talk   about rates and

 so on

 so lets take this following reaction

 so the reaction is a very simple reaction c l o minus is a hypochlorite ion in aqueous medium   reacts with bromide ions in

aqueous medium to give you b r o minus that is hyperbromide aqueous plus c l minus equals medium

 so its

an aqueous phase reaction

 so this is here hyper chloride and and as we were

discussing we are going to say you know study the kinetics of this reaction at a fixed temperature of say twenty five degree celsius or and

say two nine eight kelvin

so again as i said if you are not interested in looking at the temperature dependence then you have to look at the reaction rate at a fixed temperature isothermal conditions those isothermal conditions in this case we say that the temperature is being fixed at 25 degree celsius or 298 kelvin so that no temperature dependence is being brought into question ok lets just look at how the plot would look so this is called or the one i am going to right now or draw now is typically referred to as a kinetic plot so let us see if we can do it well so these are my two axis so these are my two axis x and y axis so in this axis i have time in seconds right here on the y axis on the y axis you can write concentration right moles per liter right for this reaction as i said hypo chloride reacting with bromide giving you hypobromide and chloride ok now first i will try to use different colors just to make sure that i can distinguish between the reactants and the products ok so first just let me draw this this is not exactly drawn to scale but hopefully it would be good enough or ok to give you the idea let this be for c l o minus then i have b r minus and i have i can write b r o minus and cl minus say this is if i try to write some numbers on the axis so this is the zero of time and then i will be having different times out ok now realize one thing when i am drawing these lines there is a small problem the problem is that they look continuous lines obviously but when you do the experiments when you do the experiments you understand that you always measure at certain points right so when you measure at certain points what you will be having is you will be having say an experimental point out here right an expanded point out here and next one point out here x 1 point out here expanded point out here and for my convenience what i have done is initially i drew the line and then i am putting the experimental points i will discuss in detail in the next class about the significance of this but what it means is i have done the experiments at each and every point corresponding to this time right this one this time this one this time this one this time and then after having done the experiment i am drawing a smooth line which is passing through these points so similarly i can put a point out here i can put a point out here for this one i can put a point out here i can put a point out here ok for this one i can put point out here here point out here right so what are you seeing what are you seeing out here is that this is the concentration on the y axis in moles per liter on the x axis you have time in seconds

so as you go along the x axis   as a function of time there are some changes in concentrations what are the changes like   if you are talking about the reactants which are hyperchloride and bromide at time 0 at time 0   when the reaction had not yet started it was just before the start of the reaction   the initial concentrations were given as here for example the initial concentration of b r minus   was this point the initial concentration of c l minus was this point now as   time proceeds because these are reactants they are slowly lost that means they are disappearing   because they are disappearing because they are disappearing the concentration of cl minus and   the cons clo minus and the concentration of br minus in the blue lines both of them   are decreasing on the other hand if the reactants are decreasing then obviously the products are   appearing that means the concentration of the products is going ahead or going up so   if you look at the green line now if you look at this green line if you look at this green line   which corresponds to both b r o minus and c l minus what you see is   before the start of the reaction before the start of the reaction there was no product out there   ok zero consideration of hyperbromide zero concentration of chloride but as the reaction   progressed that means as we progressed along the x axis as a function of time   the graph that means the plot of b r o minus and c l minus slowly went up from zero which makes sense   why because reactants are lost but products appear that means products are formed the   concentration of products increase as a function of time and that is how this kinetic profile   is looking as as it should look and it is often referred to as a kinetic reaction profile
 so again to end the class for today the blue lines refer to those of the reactants   the blue lines as you can see the lines are coming i mean the blue lines they show a decrease as a   function of time because the reactants are getting used up the green line with the experimental   points which corresponds to you know whether b r o minus a looking at c m c l minus we are looking at   this green line shows an increase from zero in value why because the products are being   formed right this is this plot it can be for any reaction but in this case we are considering a   specific reaction the reaction of c l o minus that is since we are talking about this reaction   hyperchloride plus bromide giving you hypobromide plus chloride hence this plot is referred to as the kinetic

reaction
profile for the reaction we are talking about
 so what we will do is ah we will from here we
will start the discussion in our next class okay you