hello students I am Dr. Madhavi Z.Naik
title of the unit: quantitative analysis
module name: theory of acid base titration and
choice of indicators part
one. so outline of the module: In this module what we are going to
learn is volumetric analysis,
Acid base titrations and the choice of
indicators.
learning outcomes; what students will be
able to understand or learn from this
module
students will be able to explain
volumetric or titrimetric analysis,
differentiate between the types of
titrations, understand basic terms
involved in the volumetric analysis,
choose suitable indicators for a
titration.
volumetric analysis now let us
understand what is volumetric analysis
volumetric analysis is also known as
titrimetric analysis
it's a quantitative chemical analysis
which has three major components titrant titrand or
analyte and indicator as you can see the
burette and the conical flask which is
there on the slide which are the two basic apparatus that
we use.
Now types of titrations;
we have different types of titrations
that we study under volumetric analysis
acid base titrations which you know
also called as a neutralization
titration
you have complexometric titrations
when you have a formation of a complex,
then you have redox hydrations wherein
reduction and oxidation reaction takes
place and you have a precipitation titration
in which the precipitation
takes place.
Now what we are going to
focus is on acid-base titrations so what are
acid-base titrations
acid-base titrations are basically used
to determine the concentration of
unknown either acid or a base, now how do
you find that is by neutralizing it with a base or an
acid respectively of the

known concentration so now how do we know that it has got neutralized so in order to find whether the particular acid or base has got neutralized you need to find its equivalence point and how can you find that equivalence point there are two methods either you can at each step of the titration find the pH using pH meter or you can use an acid-base indicator which would usually show you the color change.

Now basic terms involved in volumetric analysis, let us go through each of them carefully,

titrant is a reagent of known concentration

titrand is a substance that is being titrated and it's of unknown concentration also called as an analyte

now indicator is a compound which is having a physical property that usually changes abruptly near the end point that physical property is most of the times a color.

Now end point, so what is an endpoint? the point of titration at which the change in the physical property occurs it is observed just after the equivalence point. so we should know what is equivalence point it's a point of titration at which the number of moles of titrant is equal to the number of moles of titrand.

and what is a titration error? It is the difference in the volume of the standard solution in terms of the difference in end point and the equivalence point. In case the titration error is zero your end point will be same as that of the equivalence point.

so now we come to the choice of indicators how would you choose a suitable indicator for a given acid base

titration in an acid-base titration
indicators used are either weak acid or
weak base
that is highly colored. so consider an
indicator is a weak acid
and it partially dissociates in the
aqueous solution
as per the equation given below you have
undissociated form of
indicators it's a weak acid it's a
protonated form
which on dissociation gives you H^+
ions. in an ionic form of
indicator now i have just shown a
representative colors like
red and blue that is the undissociated
form of indicator will have a different
color and in anionic form it will be a
different color just as an example i
have mentioned
red and blue there now as per the
Henderson-Hasselberg equation for this
we have to calculate the pH of the
solution and the pH can be given as
 pk of indicator plus log of indicator
in anionic form upon the indicator in
the unionized form this is a basic equation
to find the
pH. Now indicator changes color over a pH
range ,now for human eyes
we can only discern any color in a
solution only when
it is 10 times intense than the other
color
so in case your indicator has to change
the color
it has to be a 10 times higher color
than the
previous one so when the concentration
of non ionized form is more
then your ratio will be log of 1 by 10
of the anionic form to the unionized
form
so your is equal to pka plus log of
1 by 10 which is equal to
pka minus 1 and when the concentration
of
non-ionized form is more finally pH
is equal to pka plus 1 so what you

notice here is
pH is equal to pka plus or minus 1 that
is it changes in the unit of 2. so most
indicators require a transition range of
about 2 pH
units, the pka of the indicator should be
close to the pH of the equivalence
point. so any indicator will be a
suitable indicator
when it has easily observed color change
and it must
immediately change the color by addition
of a half a drop of the
reagent. now this is just an image i have
shown about the indicators and their
color change corresponding to their pH, you can see the top line which shows the
pH range and these are the indicators
so many of the indicators change their
color in the lower
pH range that is in the acidic medium
some of them change the color when they
go to the higher pH
range that is seven to eight or eight to
nine as
it is given for phenolphthalein or thymolphthalein
 whereas like thymol blue methyl
orange
they change in the acidic medium and in the
lower pH.
now we will go to see a simple acid-base
titration using phenolphthalein
indicator as you can see the burette
with the stand there and initial solution
,as you add phenolphthalein as an
indicator and carry out the acid-base
titration
the color change observed is from
colorless to blue as you add the
base the color changes to pink so
phenolphthalein is the most
widely used for strong acid base
titration since its transition is
between
colorless to pink now quinonoid theory,
what is a quinonoid theory?
for choice of indicator initial theories
were dependent on fact that the indicators are
weak acids or weak bases, now this quinonoid
theory is just a revision to the oswald

theory
which says that the changes are believed
to be due to structural changes
including the production of quinoid or
the resonance forms
we initially started with the example of
phenolphthalein you can see the
structure of phenolphthalein there
now this phenolphthalein as you add OH^-
that is your base
forms a triphenyl carbonyl which
then forms a quinoid form that undergoes
resonance and as you add
excess of NaOH it forms the anionic form
and what is observed in case of
phenolphthalein is the initial
phenolphthalein is colorless and as it
goes to the anionic form it is
pink in color. now how to choose a
suitable indicator
this is just a representation of one
graph of
acid base titration where in a pH versus
the volume of your
base added is given you can see that
sigmoidal curve
now you will see a vertical portion in
the curve at 100 ml
so it's actually the equivalence point
of this particular titration.
now i have written three indicators
there phenolphthalein
bromothymol blue and methyl orange what
you can see is
phenolphthalein bromothymol blue falls
in the vertical portion whereas methyl
orange falls out of the vertical portion
so a suitable indicator is the one which
falls in the vertical portion of the
titration curve so in this case you can
either use phenolphthalein or
bromothymol
blue this is the way you choose the
indicator colour of indicator
for this particular titration, initially
your titrant or analyte will be
colorless as you add
the indicator it will be
showing pink color as the titration is

going on and as you reach the
equivalence point which gives your
end point.
these are the references
thank you