[Music] [Applause] hello welcome to this lecture module on optics in in the last couple of lectures we discussed about refraction through a spherical surface and then also refraction by lenses and application of this in optical instruments such as microscopes and telescopes today we come to the last topic on of ray optics that is refraction through a prism and we will also briefly discuss about the topic of dispersion
So refraction through a prism and dispersion that will be the topic of this lecture first refraction through a prism
So here is the slide
So what i have shown is the cross section here top view of a prism a ray of light is incident from here it undergoes refraction at two interfaces because refraction through a prism involves successive refractions at a two planar interfaces at an angle one interface like this between a denser rarer medium and the medium of the prism and the second interface is here the two interfaces are at an angle and refraction takes place at the two interfaces leading to deviation of the incident light the incident light refracts and again refracts and emerges from here
So this is refraction through a prism i is the angle of incidence here d is the angle of deviation that is angle between the original direction of the incident beam and the emerging ray here and n1 and n2 are the two normals to the surface here and e is the angle of emergence a is the angle of the prism it is actually called the refracting angle of the prism
So whenever we talk about refraction through a prism a is referred to as the angle of the prism these two angles do not come into the picture and therefore a is referred to as the angle of the prism b c the lower surface here is usually a grounded surface which helps in blocking any stray reflections because that is not coming into play in this part of the refraction
So before i proceed with the refraction let me briefly recall what i had shown and here
So what i have what i am showing is the prism and what we have seen is the top view of the prism and the ray of light is coming from here
So let me again show you a laser beam incident in this direction along the direction of the ray that i have
So here is the laser beam and we can see that the beam comes here on to the other side along the other line which i have drawn see the ray which is emerging ray is coming along it is coming along the emerging ray the ray b the laser beam is coming along the emerging ray after refraction through the prism
So this is the here is the input beam as you can see if i block then there is nothing coming out there
So there is the input beam there is no laser beam coming from here a small amount of reflection is coming here but the major part of the light beam is refracted through the prism and comes along this line here
So if you change the angle of incidence here the angle of emergence will also change i am just showing you that angle of changing the angle of incidence and the angle of emergence also changes here right
So we will come back to the discussion on refraction through the prism
So i have already discussed each of these quantities here and let me proceed further now
So refraction through a prism
So this time i have shown slightly a bigger prism here ah to make the angles very clear
So let us see here right
So first [Applause] see the prism the incident ray undergoes refraction here this is the direct path of the ray if the prism were not there and this is the deviated ray and emerging ray and therefore this is the angle of emergence
So what we can see here is angle theta 1 plus angle theta 2
So the total angle of deviation d is angle up to this and from here to here from here to here it is theta two that is shown here and here to here is what is shown here as theta 1.
So d is equal to theta 1 plus theta 2 in this diagram now what is theta 1 theta 1 is i minus r 1 there is r 1 here r 1 is the angle of refraction at this interface and r two is the angle here which is actually the angle of incidence from this direction but would become angle of refraction if light with ray was to be incident from this side and therefore this whole angle is i and therefore theta one is equal to i minus r one similarly theta two the angle theta two here is the this is the emergent ray
So emergent angle e is here

So this is entire angle is e emergent angle r 2 this is r 2
So the opposite angle there is r 2 and therefore theta 2 is equal to e minus r two
So we have i minus r one plus e minus r two or i plus e minus r one plus r two that is the angle of deviation but if we look at this quadrilateral here then we can see that this angle is 90 degree this angle is 90 degree i am looking at a q m n a q m n note that this is the normal and therefore angle a q m is 90 degree angle a n m is 90 degree
So the sum is 180 degree that means angle a plus angle m or angle q m n must be 180 degree
So angle a plus angle q m n is equal to 180 degree but in this triangle looking at the triangle q m n angle m plus r1 plus r2 is also 180 and therefore r1 plus r2 is equal to a r1 plus r2 is equal to a the angle of the prism
So we can substitute in this equation here and therefore we have a is equal to r 1 plus r 2 and d is equal to d is equal to i plus e minus a
So we call this as equation 1 and two n two is the refractive index of the prism and n one is the outside medium refractive index of the outside medium which is usually air outside now this is when the ray comes in this direction and goes and refracts and emerges out from here what if the ray were to be incident from this direction along this path the reversibility of light says that the ray would trace the same path again
So let me show this slide here and we see the reversibility of light
So we see that if the ray were to come from here that is if this would have been the incident angle then at this point again the snell's law would be satisfied and the ray would follow the same path and then it will again satisfy the snell's law and follow the same path here which means if i is the angle of incidence when incident radiation or incident ray is from here then e would have been the angle of emergence however if the ray were to be incident from here at an angle e then i would be the angle of emergence in both cases what we see is whether the ray is incident from here or the ray is incident from here the net deviation is the same d it is identical and therefore here e goes over to i when the ray reverses from in this direction reversing the direction of the incident ray e goes over to i then i will go over to e but no change in d d is the same in both cases as you can see they are opposite angles here and d is equal to i plus e minus a here also we can see that if you put i plus e or e plus e i its one and the same d remains the same therefore if we reverse the direction of propagation of the ray i and e would get interchange but d remains the same this indicates that for two different values of i because i and e d is the same but i and e can be different only thing that we have said is when i becomes e e becomes i but i and e may be different and therefore for the same value of d we will have two different angles of incidence for two different values of i d will be the same therefore there must be a point of degeneracy that is i is equal to e this is our conjecture we will see what we get now coming back to the problem and calculating the angle of deviation here
So d versus i we are now interested in determining the angle of deviation versus the angle of incidence we have the snell's law at this interface and this interface at the first interface
So this is the first interface i have shown a small diagram now first interface sine i by r1 r1 is the angle here and therefore sine i by sine r1 is equal to n2 by n1 snell's law applied to this interface and snell's law applied to this interface gives sign r two by sign e because angle of incidence here is r two angle of emergence is here the refracted angle
So sine r two by sine e is equal to n one by n two n one is now the second medium outside medium n1 by n2 for the second interface therefore for a given prism n2 and a are constants the material of the prism has a certain refractive index n2 and a n angle a here they are they are known for a given prism and therefore for each angle i for each angle i we can calculate r1 because we know two and n one
So using snell's law we can calculate r one once we know r one we know r two because r one plus r two is equal to a and once we know r two we can calculate e because we know n one and n two sign r two by sin i is equal to n one by n two
So for each angle i r one and hence r two and then e can be determined which implies that angle of deviation d can be calculated for each angle of incidence as discussed earlier by the reciprocity of light propagation i and e are interchangeable which means for each d there will be two values of i
So let us plot this for a typical case of d versus i
So here

So i am showing a graph here of d the angle of deviation versus i
So typical angles
So what is shown is a qualitative plot of d versus i d angle of deviation versus angle of incidence for a typical prism of a is equal to 60 degree and n is equal to 1.5 this is how it looks
So what is to be seen is as i increases for any value of d we can see that there are two values of the angles of incidence when this is i this will be i e and when this value is i this will be e
So for each value of d there are two angles of incidence
So if we come down however there is a point here where it becomes minimum the deviation passes through an extremum here
So this is minimum at that point i is equal to e because there is only one value of the angle of incidence and the corresponding angle of deviation is called the angle of minimum deviation if you start from one end go on increasing i then the angle of deviation will come down initially come down to a minimum value and then it will again start increasing and this angle of minimum deviation is designated by dm the point is at this value of dm i is equal to e for all other values there are two values of angles of incidence whereas at the angle of minimum deviation i is equal to e
So substitute norm therefore d is equal to i plus e minus a d m is equal to 2 i minus a because i is equal to e
So it is 2 i minus a or i is equal to a plus d m by 2 the first equation i is equal to a plus d m by two
So now let us look at when i is equal to e r one is equal to r two is equal to r if i is equal to e
So if we look at the diagram here when i is equal to e that means if i is equal to r an angle of incidence i gives an angle of refraction r1 then an angle of incidence from this side which is e will also give the same angle of refraction r2 which is equal to r1 because the refractive indices are the same n one and n two n one and n two and therefore r one must be equal to r two if i is equal to e
So at the angle of minimum deviation what we have is r one is equal to r two and we call it as r and therefore from r one plus r two is equal to a we have r is equal to a by two
So we have two equations here a plus d m by 2 is equal to i and r is equal to a by 2. now using these two equations 1 and 2 we apply the snell's law sine i by sine r is equal to n two by n one substituting for i and r from one and two we have sine a plus d m by two divided by sine a by two usually of course the n two is the refractive index of the prism and two here is refractive index of the prism and n one is the outside medium and usually outside medium is air and therefore n 1 is equal to 1 and n 2 is equal to n where n is the refractive index of the medium and therefore we write therefore we get the formula for refractive index of a prism as n is equal to sine a plus d m by 2 divided by sine a by 2 where a is the angle of the prism and d m is the angle of minimum deviation this is an important formula and it is used in practice to determine the refractive index of the material of a prism an important experiment which is used to determine is with the experiment with a spectrometer
So this is also not a part of our course but i would just like to show that to impress upon you that the angle dm of minimum deviation is a measurable quantity and therefore we can determine the refractive index very accurately using a spectrometer a spectrometer comprises of a collimator which sends a collimated that is a parallel ray from here and then the ray passes through the ray passes through the prism which is placed on a prism table with the top view looking from the top
So there is a prism table on which you place the prism and light passes through the prism refracts and the refracted light is detected by seen by a telescope there is a telescopic arm through which you can observe the refracted ray
So using this arrangement one can determine the angle of minimum deviation practically one can measure the angle of deviation and of course the angle of prism a can also be measured and the refractive index of the material of the prism can be determined using this formula very accurately
So this is the importance of this formula which we have derived and there is no approximation involved we have not made any approximations in deriving this formula now for thin prisms
So this is for normal prisms but for thin prisms the angle a is very small thin prism means the angle a is very small i have shown here its a thin prism a is very small and of

course the thickness of the medium is also very small and therefore the d is also very small because the thickness of the medium is very small it is quite thin and therefore the angle of incidence is very small angle of refraction is very small and therefore we see that the angle of deflection or deviation here is very small because a is very small and therefore n which is given by this formula that we have derived can be approximately written as the sign theta can be approximated to theta that is a plus d m by two divided by a by two when a is very small which is equal to one plus d m by a you can divide this and see that this is one plus d m by a in other words d m the angle of minimum deviation is equal to n minus 1 into a we can clearly see that when a is very small d m is also very small

So the formula is quite useful when a is very small one can immediately determine dm now there can be several pro solutions several problems several examples which can be worked out based on the prism formula ah that is n is equal to sin a plus d m by two divided by sine a by two various situations ok

So let us take an example of refraction through a prism

So lets see this consider a glass prism of equilateral triangular cross section and refractive index 1.6 refractive index of the material is 1.6 what should be the angle of incidence on the refracting surface for a ray

So that angle of incidence equal to angle of emergence second part if the prism is immersed in water refractive index is given n is equal to 1.33 what would be the angle of minimum deviation

So let us try to understand this problem

So consider a glass prism of equilateral triangular cross section

So let me ah write the draw the diagram here

So we have a glass prism of equilateral triangular cross section

So this is actually the top view as we have seen in the actual prism

So equilateral

So the information given is angle a is 60 degree there is a ray of light which is incident here and it refracts and emerges out from the other side the question is

So this is the normal here and the normal here

So what the first part is

So the refractive index is given n 2 here 1.56 1.56 if the refractive index of the outside medium is not given then we assume that n1 is equal to n1 is equal to 1 that is air because in general the prism is placed in air and therefore n1 is equal to 1.

So the question is what should be i

So that i is equal to e

So this is this angle is the angle of emergence and here is the refracting angle r1 and this is r two

So r one r two a the angle operand

So given n two is equal to one point five six a is equal to 60 degree

So the first part of the question is what should be the angle of incidence that is i for a ray

So that angle of incidence is equal to angle of emergence

So i is equal to e

So i is equal to e i is equal to e implies r one is equal to r two r one is equal to r two is equal to a by two we have already seen this because if i is equal to e that means r one must be equal to r two because is the same interface same refractive index separation here and i is equal to e and therefore r one must be equal to r two and then this will be equal to a by two we have already seen this because this is ninety degree this is ninety degree therefore a plus this is equal to one eighty degree and r one plus r two plus this angle here that is if i extend this this angle here will be 180 degrees and therefore r 1 plus r 2 must be equal to a and therefore r 1 is equal to r 2 is equal to a by 2 because a is 60 degree we have this is equal to 30 degree r 1 is equal to r 2 is equal to the question is what is i we know refractive index here we know the refractive index here we know the angle of refraction here and therefore we can determine i simply by applying snell's law that is sine i

So for the first part applying snell's law sine i divided by sine r one is equal to n two by n one

So n two by n one which is equal to one point five six divided by one because n one is one

So r one is thirty degree therefore sine r one is half that is point five

So here

So let me take it further therefore sine i here is equal to 1.56 into sine 30 degree sine r 1 sine 30 degree which is this is half and therefore this is equal to 0.78 and therefore i is equal to sine inverse sine inverse of 0.78 of course you need a calculator to get the angle but the numbers can be chosen in such a way that you sometimes do need a calculator

So this can be calculated and we get this as equal to 51.26 degree 51.26 degree i is equal to that is this angle here i comes out to be 51.26 degree

So this is the first part that what should be the angle of incidence i is equal to e of course we can determine the angle of minimum deviation d m

So d m is equal to twice i minus a twice i minus a that is how we got i is equal to a plus d m by two

So d m there is the angle of minimum deviation in this case in the first part of the question d m is not asked but we can just calculate for interest that this is equal to

So fifty one

So hundred and two hundred and two point five two minus a that is sixty

So this is equal to forty to forty two point five two degrees this will be the angle of minimum deviation in the first case but that is not asked in the question in the question we have angle of minimum deviation for the second part if the prism is immersed in water what would be the angle of minimum deviation

So how can we work out exactly like that is the same prism

So here

So we can again draw the prism but this time the outside medium is

So the ray is here

So everything remains the same except that

So except that this is now 1.56 but outside medium is three three all other things remain the same if the prism is immersed in water what would be the angle of minimum deviation

So now we have

So how do we go about this

So we can again apply snell's law because i is equal to e is the condition which gives us r 1 is equal to 30 degree independent of what the medium is but if the outside medium is one point three three the snell's law will be sine i by sine r

So in this case i apply here it is sine r one

So this is equal to n two by n 1 n 2 by n 1 which is equal to n 2 by n 1 which is equal to 1.56 divided by 1.33

So r one is thirty degree and therefore sine i is equal to

So this is half

So one point five six divided by one point three three into half

So one by two

So two

So that is equal to

So this is point seven eight by one point three three

So point seven eight by one point three three

So we will substitute this

So i is point seven eight by one point three three and therefore i is equal to

So i is equal to sine inverse of 0.78 by 1.33

So if you use a calculator we can find this out as 35 point

So now the angle has reduced 35.90 degree therefore the angle of minimum deviation

So in this question we have angle of minimum deviation is equal to twice i minus a

So that is equal to 35.9 into 2

So that is 71 point eight minus sixty degree here

So that is equal to eleven point eight

So eleven point eight

So we have we why i had calculated dm in the earlier case was because we got dm is equal to

So the dm that value that we got earlier was 42 here it is

So dm was 42.52 degree but now the dm is 11.8 degrees obviously it is understandable if we see the figure that if the refractive index here is 1.33 then the refraction will be much smaller if i has to be equal to e i has to be much smaller because the refractive index difference is much smaller that is how we have got i is equal to a smaller number 35.90 and the deviation is equal to 11.8 degree of course we could have also used the

other formula we could have used the formula for refractive index

So we had n two one is equal to n two by n one is equal to sine a plus d m by two

So sine a plus d m by two divided by sine a by two and we will get exactly the same answer sine a by two

So in this case we know that n two is given

So one point six divided by 1.33 is equal to sine of a a is known

So a by 2 is 60 by 2 is 30 plus dm by 2.

So d m by two divided by sine thirty which is half

So half goes there and we will have the same expression again that one point five six divided by one point three three into two half

So it is into two here is equal to sine thirty plus d m by two

So if you simplify this

So the we will we take the inverse of this

So sin inverse of one point five six that is by two is point seven eight

So it is one point three three into two is equal to thirty plus d m by two

So we can bring this to this side and we will get the same answer

So calculate calculate d m is equal to 11.8 degrees as before 11.8 degrees

So either we could use this formula it is not necessary that we have to use the same formula

So in this case once we identify the picture once we have recognized the picture then it is possible to simply apply snell's law here we need not go to the other formula of sign a plus dm by 2 by sin a by 2 and that is what i have shown through this example and let me take up the next topic which is dispersion

So dispersion

So it is if the fascination with the glass prism the most whenever when we think of dispersion the first impression is that white light incident on a prism disperses into different colors that is the first impression that we have when we talk of dispersion or when we talk about the prism

So what is shown here is incident white light which disperses that is which spreads out into its component wavelengths white light comprises of large number of wavelengths or almost a continuum of wavelengths we know that the visible radiation has wavelengths ranging from 400 to 750 nanometers and white light when the visible white light when it is passed through a prism it disperses or spreads out into its component colors and the colors come in this order that is violet indigo blue green yellow orange whip cure

So violet bends the most and red bends the least here and in between we have a colorful spectrum color ranging from red to violet or violet to red in this direction

So this is called a spectrum that is it is called the white light spectrum vib cure

So varying from violet end around 400 nanometer to the red end around 650 or even 700 nanometer

So this is what we call as dispersion now why does this happen why does dispersion happen

So let us discuss this in a little bit of detail

So here dispersion dispersion happens because refractive index of a material depends on the wavelength of light that is n is a function of lambda n is a function of lambda now let us take some examples and discuss it further the widely used materials in glass prisms are crown glass flint glass and fused quartz that is silica pure silica

So these are the widely used materials in making glass prisms the variation of refractive index n with wavelength is shown in the next slide

So i have already plotted this variation qualitative plot of the refractive index variation with the wavelength

So we can see here n refractive index versus wavelength we can see that in all cases n is continuously decreasing as wavelength is increasing

So the refractive index decreases with wavelength for all the three materials the actual value of the refractive index is different for the different three different materials but the refractive index varies with wavelength in the same fashion but the rate at which the refractive index changes will be different for different materials

So that is called dispersion dispersion for different materials will be different but qualitatively refractive index decreases as wavelength increases

So this is what is called dispersion

So let me give some typical numbers values here

So that we have an idea what is the change in refractive index as we go from blue color to the red or vice versa

So here in this table i have noted down the refractive index values for four at four different wavelengths actually these three wavelengths are from the hydrogen spectrum lines corresponding to the hydrogen spectrum and this is the sodium line five eight nine point three nanometer is the sodium line
So few squares the refractive index values
So it is highest for violet one point four seven zero and keeps on decreasing four six three four five eight four five six the change is not much but it is continuously decreasing you see the same thing for crown loss 1.533 523 517 and 515 and for the flint glass one point six six three six three nine and
So on we can see that the maximum change is approximately point zero four one here whereas the maximum change here is point zero one four this is point zero four one a change
So one six six three
So six six three two two two two
So two two that is sixty three to twenty two is forty one whereas in this case seventy to fifty six it is one four ah we can see if i keep back the diagram the refractive index change is large as i go from here to here for flint glass but for few squads the change is very little it varies very little that is what the numbers also tell us now the variation of refractive index of a material follows approximately one by lambda square dependence
So if i were to plot the variation of refractive index that is n versus lambda then for most of the materials the refractive index varies like this it is continuously dropping down here it is n and this is lambda the relation is given by this is approximately proportional to one over lambda square this was experimentally observed and then koshi gave a formula which is called cautious formula cauchy
So cautious formula n of a material is n of lambda is equal to a plus b by lambda square where a and b are constants a comma b are constants constants for a given material they are not universal constants constants for a given material given material they are also called cauchy is constant a and b are called cauchy's constants now let me go further before i come further i want to talk about one topic which is called dispersion compensation dispersion and dispersion compensation are very important and huge topics but let me just introduce you to dispersion compensation in its simplest form
So what is shown here is a prism here white light entering a prism which leads to dispersion that is spreading of the component lights which are entering now is coming here if we place another prism inverted as i have shown here it could be of the same material or it could be of different material usually a different material and different size is used for certain reasons which is beyond our scope of discussion here but what we can see is that the spreading is compensated by the second prism the inverted prism compensates for the spreading because this was bent more in this direction now the second prism bends it more in the other direction whereas red had bent less but also it is bending less the net defect is both of them combine here to form the white light again in other words we started with white light and using the first prism the way components were dispersed dispersed means they are spread now the second prism because its inverted it combines
So that we get back the white line
So by choosing a second prism of appropriate size and refractive index it is possible to compensate for the dispersion of the first prism
So this is in simple terms what is meant by dispersion compensation i want to take one example from nature and that is formation of rainbows
So formation of rainbow this is an effect because of dispersion of the different colors the formation of rainbow which most of us have seen just after the rains if the sun comes out and we still have water droplets in the air and then the we there is a possibility that we might be able to see rainbows otherwise of course near great waterfalls big waterfalls like the niagara waterfall where water posed down from a large height huge quantity of water continuously pouring down leads to water droplets sprayed upwards and whenever there is sun there is a possibility of seeing rainbows almost every time one can see the rainbow if sun is present at the right angle
So what is shown here is these are the water droplets ah shown it a little bit bigger this is the water droplet light sunlight is coming array of light is representing here white light enters the water droplet it disperses red and blue separates out it undergoes total internal reflection because outside it is air and this is water

So it is denser to rarer and if the angle is such that this angle is greater than the critical angle then it can undergo total internal reflection and then it refracts out now in the process as illustrated in the diagram here we can see that red comes at a larger inclination the inclination angle with the horizontal

So i am talking about the inclination angle with this horizontal

So red comes out at a larger inclination and blue comes out at a smaller inclination and therefore because of the refraction the dispersion which is taking place inside the medium and therefore an observer here i have represented an observers eye an observer sees red at a higher angle because it sets a larger inclination

So for him it appears as if red color is coming from a position somewhere here in the horizon and blue color comes from a lower position in the sky and therefore we see red yellow green blue in this order the rainbow colors are visible in this order if the situation prevails like this there are situation situations when the color may interchange depending on if there is a second refraction undergoing that there is ah a ch possibility of interchange of colors but the formation the point in this is the formation of rainbows is because of dispersion taking place in the water droplets dispersion of sunlight taking place in the water droplets near waterfalls and soon after rain

So i will observe red color it is it it depending on the size of the water droplet it can be shown that the red color has a net deviation of 42 degrees while blue undergoes a deviation of 40 degrees

So therefore blue becomes more horizontal and red becomes more inclined and when you see from here red goes up and blue stays below in the sky

So i will observe red color making a higher inclination with the horizon will appear at the upper part of the rain now i have brought in i have just introduced the topic of dispersion at the most elementary level the first level now if white light was undergoing dispersion then it passes through a prism why didn't we talk about this earlier we have discussed refraction through a prism refraction through a lens reflection and at a mirror nowhere we have talked about dispersion what is the effect of dispersion in the discussions that we had earlier

So let us look first first refraction at the prism one in the case of prism in the case of prism i am discussing what is the effect of dispersion in the discussions that we had we derived

So here is the prism and this was the angle of incidence and here the refracted ray and then we had this angle of deviation d angle a and refractive index of the prism and then we said n is equal to sine a plus d by two a plus d m actually this is true for angle of minimum deviation d m by two divided by sine a by two but we said n is a function of lambda and therefore strictly speaking

So a is a constant and therefore the deviation here d m is also a function of lambda and this formula is strictly correct only for a given wavelength one wavelength one lambda it is correct for one lambda in other words if we measure the minimum deviation for a particular wavelength that is for blue color or yellow color or red color then we can determine the corresponding refractive index at that wavelength

So if i measure d m for blue then i would get n m and b that is n of lambda for the blue color

So n of blue n for the blue color will be equal to this if i measure d m at blue at loop

So in the case of a prism in this discussion the discussion is strictly true for a particular wavelength but normally we consider the the yellow light of sodium aloe light and assume that all the discussions that we have are for yellow color but otherwise this formula is true for a particular color or a particular wavelength only now in the case of thin lenses we have next considered before that we have considered thin lenses

So two in the case of thin lenses thin lenses observe that i have deliberately shown it very thin now thin lens the angle

So the angle here is very small if i break this into segments then the top segment looks like a prism but a is very small a is very small even in other cases if i have a segment like this a segment like this then of course its part of a prism where the a is very small i am using only the ray i am using only here

So refraction undergoing refraction and then undergoing refraction but a is very small and therefore we have d is equal to n minus 1 into a we have derived this for thin prisms d is equal to n minus 1 into a if a is very small deviation is very small what it means is although n is a function of lambda

So strictly speaking this is n of lambda minus 1 into a therefore d of lambda d will have

a dependence on lambda however d itself is very small if a is very small and therefore the dependence on n lambda is very small in other words that the difference
So d of d for blue color minus d for red color this difference will be very small because d itself is very small in the case of thin lenses that is why we have considered thin lenses and third in the case of mirrors in the case of mirrors our first discussion were with mirrors in the case of mirrors there is no dispersion why there is no dispersion because light does not propagate through the mirror it is reflected from the mirror and therefore there is no defect light is only for dispersion light has to propagate through the medium whereas in the case of mirrors there is no dispersion because light is only reflected from the mirror light is reflected we assume that it does not enter the mirror and therefore dispersion does not affect in these two cases but indeed dispersion is an important issue in the case of a prism finally as i mentioned dispersion is a huge topic it is not just in optics it is important in various branches of physics and also in engineering what it basically means is whenever a system a systems output or systems performance or systems characteristics depend on the frequency we have discussed about wavelength because it is convention to deal with wavelengths in the case of light because of convenience of the numbers but wavelength or frequency are interchangeable and whenever a systems characteristic is frequency dependent there will be dispersive effects or dispersion this is a very important topic but every time dispersion is introduced from dispersion of white light the colourful spectrum the viv your spectrum of white light that one see when light passes through a prism you