Experimental Physics - II
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Lecture – 24
Discussion on angle of the prism, angular dispersion and dispersive power of given prism

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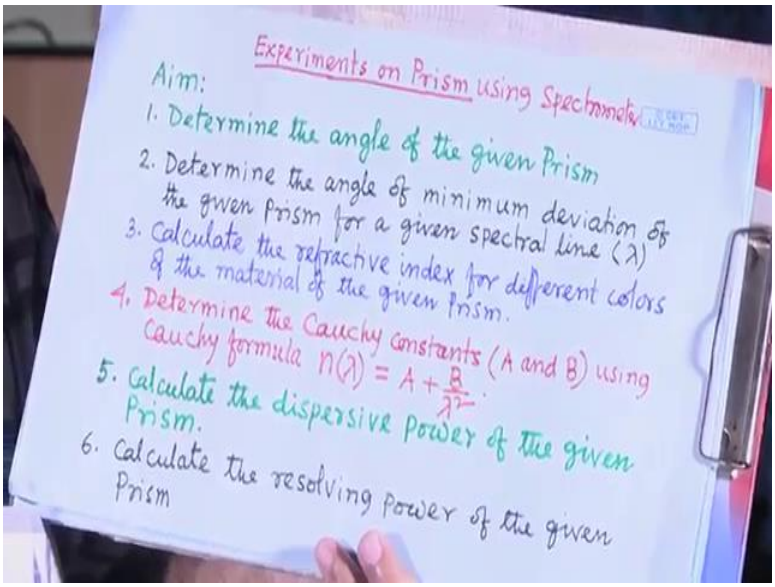

today we will demonstrate experiments on prism using spectrometers so far, we have shown you the spectrometer how it works, what are the components of the spectrometer. for doing experiment either using prism or getting. we need to need to adjust the spectrometer for parallel rays and to see the image, all short of adjustment levelling that we have shown.

Now today the spectrometer I will assume that the spectrometer is levelled, and it is focus for parallel rays. Now today we will do experiment using prism. what is the aim for this experiments using the prism? aim of the experiments determine the angle of the given prism.

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if prism is given; if prism is given now, what is the angle of the prism, what is the angle of the prism that one can determine. Then second determine the angle of minimum deviation of the given prism for a given spectral lines means for a particular wavelength of light one can find out one can determine the minimum deviation of the prism. Third is one can find out the refractive index of the material of this prism. next this minimum deviation depends on the wavelength; angle of the prism does the depend on the wavelength. refractive index if you see the formula. that also is a function of wavelength,

how refractive index depends on the wavelength? there is a formula relation. that is called Cauchy relation Cauchy formula. there is n refractive index as a function of lambda equal to A plus B by lambda square, A and B are the constant for the prism. refractive index depends on the lambda. this is the relation. using this using experiment one can find out these Cauchy constant that also we will demonstrate, we will perform the experiment next calculate the dispersive power of the given prism. Prism has dispersive power that is because of this refractive index depends on the wavelength.

dispersive power of the prism one can calculate, one can find out, also one can find out the resolving power of the given prism. if a prism is given to me, then using the spectrometer I can do experiment and I can find out what is the angle of the prism, what is the minimum deviation of the prism for a particular wavelength of a light, also one can find out the minimum deviation of the prism for different wavelength. One can find out the refractive index of the material of the prism and refractive index is a function of the

wavelength of the light one can find out the refractive index as a function of wavelength, how refractive index varies with the wavelength one can find out

And one can verify the relation between the refractive index and the wavelength that is Cauchy relation Cauchy formula and dispersive power; dispersive power of the prism as well as resolving power of the prism what are those or what are the meaning of those terms that let me explain first.

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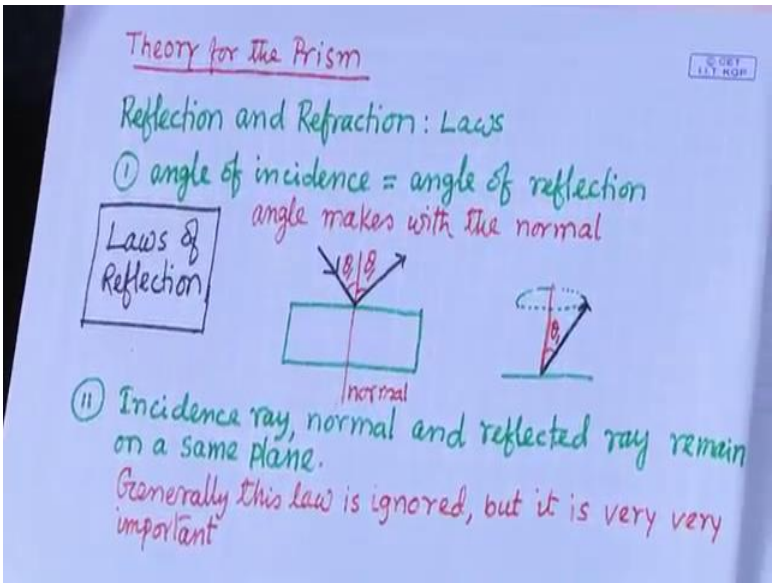

these experiment is based on purely refraction and reflection of light, ok reflection and refraction laws of reflection laws of refraction are well known to all of us buts just I repeat those laws. this is the reflection from a medium it can be prism also. here all of us we know that angle of incidence is equal to angle of reflection this is the first law. Second law is ignored what is very important; like incident ray normal and reflected ray remain on a same plane. this is very important because this is the angle of incidence angle of reflection. this one it can be on this plane, this can be on other plane all this ray can be on other plane also

it may form a cone; it may form a cone with the same angle of reflection ok you will see this reflection either in this direction or in this direction with the same angle this first law cannot tell. According to first law one can see this reflection in this direction also one can see in this direction But second law tells now it is not possible to see in this direction, it will be along this direction because this incidence ray, reflected ray and the

normal these three has to be on the same plane. these the plane of incidence, it called plane of incidence is the in this case plane of vapour is the plane of incidence. this second law is very important although it is ignored.

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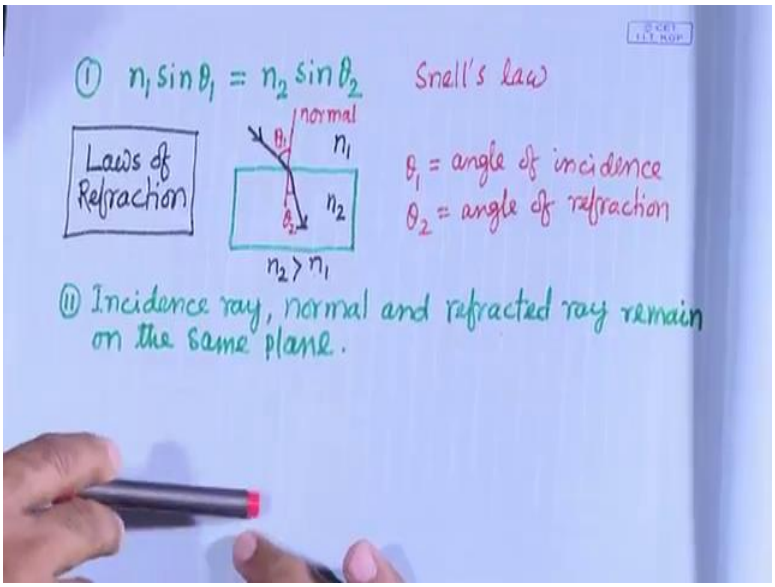

next refraction, refraction you know this Snell's law. it is incident ray, and this is the refracted ray, this is the normal, again second law of refraction is same as the second law of reflection. incidence ray normal and refracted ray again remains on the same plane n of vapour.

it can be refracted in this direction, it can be the refracted in this direction keeping the angle same, but this direction is not allowed as per the second law, but as per the first law it is allowed, So and first law is Snell's law; Snell's law this, n 1 n 2 if the refractive index of first medium and second medium and this incidence angle theta 1 and refracted angle theta 2. n 1 sin theta 1 equal to n 2 sin theta 2, if other mediums are there, then also n 3 sin theta 3 etcetera, etcetera one can write. there is the Snell's law.

according to Snell's law n 1 sin theta 1 equal to n 2 sin theta 2 ok; theta 1 angle of incidence and theta 2 angle of refraction this two cases one is reflection, and another is refraction.

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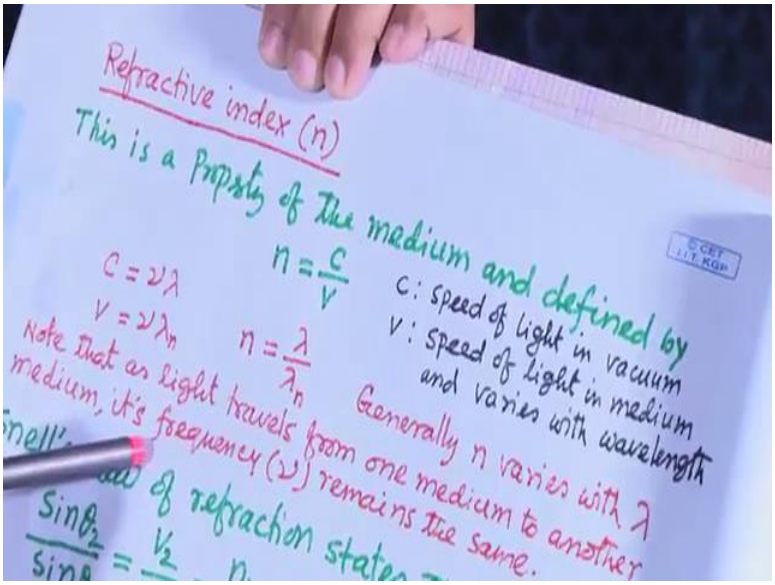

this we will use for prism experiment of prism theory. then refractive index is very important for refraction, this is a property of the medium and defined by n refractive index equal to velocity of light in vacuum divide by velocity of light in the medium that is the refractive index of the medium,

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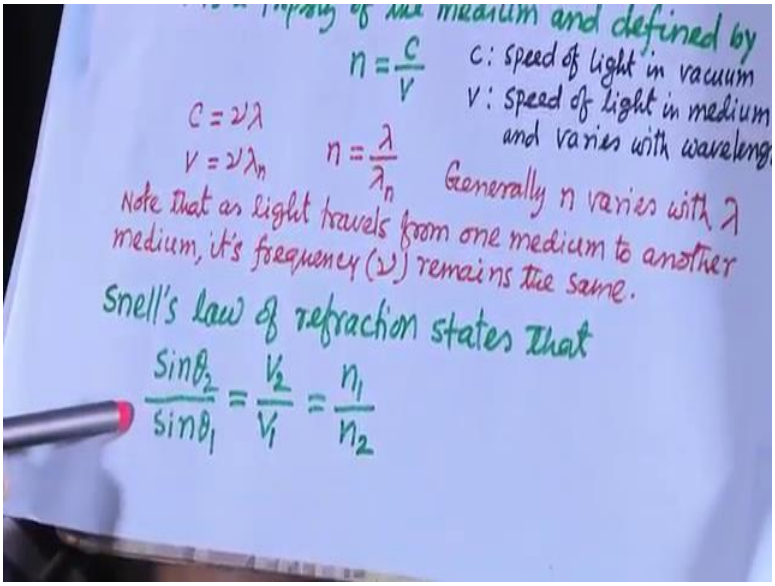

one can write n equal to lambda by lambda n; lambda n means wavelength of the light in the medium and this lambda wavelength of light in the vacuum this relation has come C velocity equal to frequency into wavelength. from here using this relation one can get refractive index equal to ratio of the wavelength of in vacuum as well as in the medium.

So light travels from one medium to another medium that time this is frequency really does not remain same only it is wavelength changes. that is why we have use this relation. according to Snell's law; refractive index one can write that n 1 sin theta 1 equal to n 2 sin theta o 2 sin theta 2 by sin theta 1 refract refracted angle and incident angle. that equal to ratio of the refractive index of medium one and medium two if medium one is here. then n 1 will be one and n 2 is same. 1 by n equal to sin theta 2 by sin theta 1; n equal to sin theta 1 sin of angle of incidence divided by sin of angle of refraction that is the refractive index. these are well known I think class, in class 10 we have learned about this.

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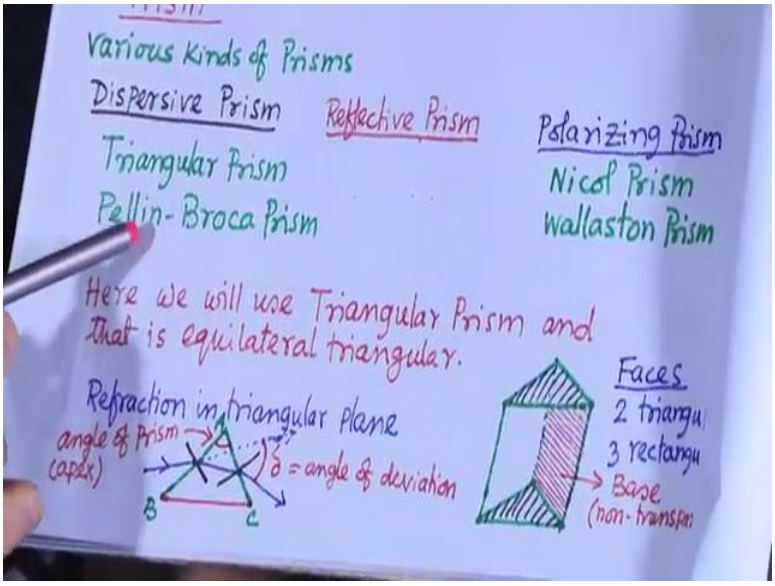

Now, prism we will use prism for this experiment. actually, various kinds of prisms are available dispersive prism, reflective prism, polarizing prism; different kinds of prisms are available. dispersive prism they again different kinds of dispersive prism, so triangular prism, Pellin-Broca prism ok, Polarizing prism, Nicol prism, Wallaston prism. these four names I have written here because I have used these four types of prism.

that is why just I have there are many types, but I mentioned only this four because I have used this and probably, I will use those prism for different experiment in optics and show you. in this case here we will use the triangular prism triangular prism and it is equilateral triangular prism. it is this type of shape of the prism this type of shape of the

prism. it has two rectangular phase this and this one and three sorry two triangular phase and three rectangular phase

This is triangular phase and this one also and this three rectangular phase this one then this and then other one. out of this three rectangular phase one is base, it is the optic one, it is non transparent and two phases two rectangular phases are transparent for reflection and refraction will use this two transparent phases; when light fall on the prism, then here to this medium there is a diffraction and again when it exit from the other phase, here again refraction from medium to the here. there will be there; this we tell this a emergent ray emergent ray this is a incident ray,

this is the incident ray; this is the direction of the incident ray is this and direction of the emergent ray is this. actually after refraction in the prism we are getting light is deviated from the original direction and it is going in this direction. what is the angle of deviation? if you extend this. this is the angle of deviation. reflected one is deviated from the original direction this is the angle of deviation and this is the angle of incidence this is the angle of reflection.

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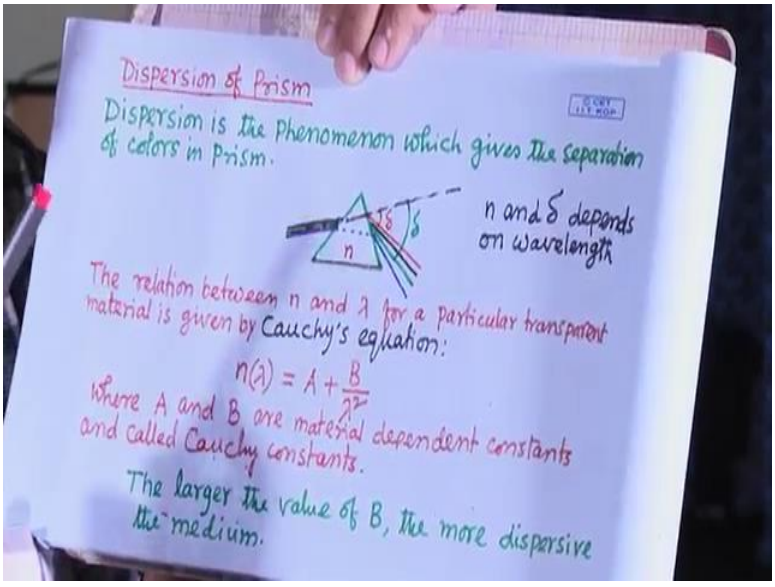

this is about the prism and this although very simple and well known to all of us and what is dispersion? Dispersion is the phenomena which gives the separation of colour in prism say white light; white light means it has all sorts of colour it consists of different many wavelengths means of different colour.

when it passes to the prism; when it passes to the prism or any other getting then if the colours are separated specially, if the colours are separated specially in space if you see that separately that is called dispersion. And how much the spacing will be between different colours among different colours. that is the power of prism. that we express in terms of dispersive power of the prism.

the relation between n lambda for a particular transparent material is given by Cauchy's equation as I mentioned. this is related with this refractive index of this material of the prism and the wavelength of the light

this it is; it is related with the dispersion and of course, the larger the value of B; larger the value of B, what is the relation here? this is the constant A plus B by lambda square, if B is larger than this dispersion of the medium will be more that is the importance of this constant of the material, that is why from experiment we try to find out the Cauchy's constant because if you find the material which is having the higher the value, then the dispersive power of that medium will be higher.

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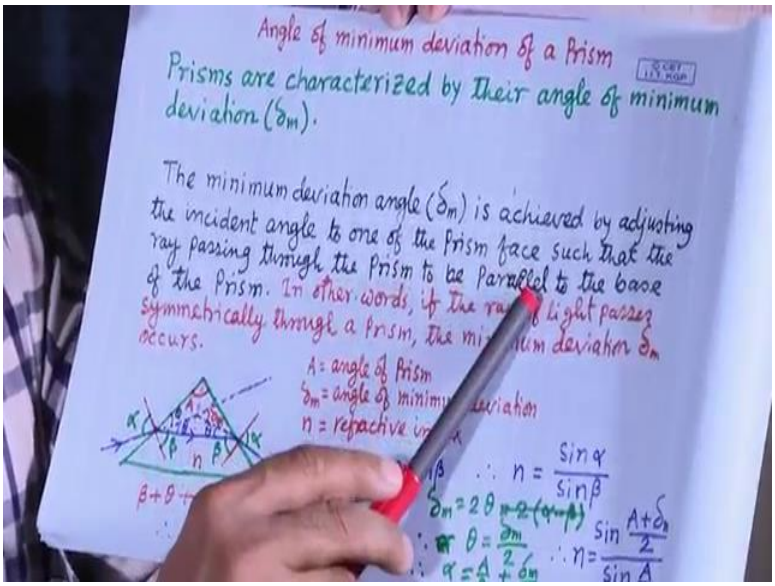

now another important characteristics of prism is the angle of minimum deviation. prism is characterised by their angle of minimum deviation. the minimum deviation angle is achieved by adjusting the incident angle to one of the prism face such that, the ray passing through the prism to be parallel to the base of the prism.

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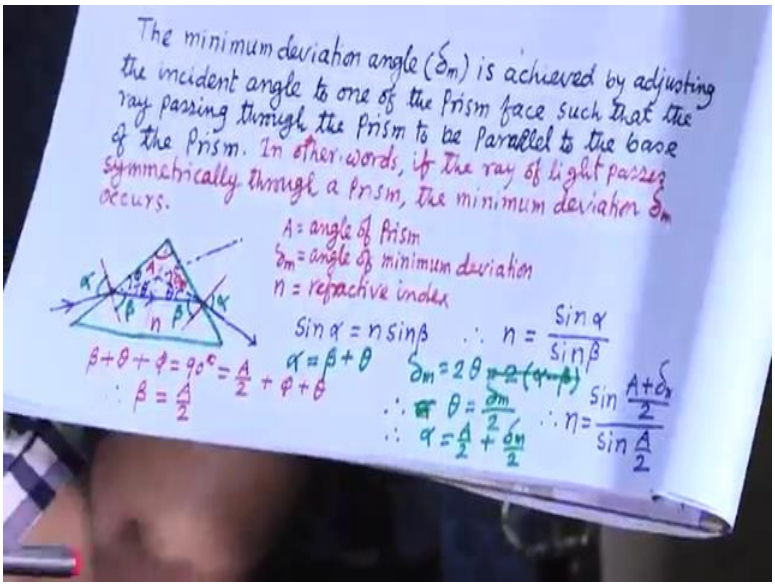

This angle of incidence will be adjusted such that the refracted ray inside the prism will be parallel to the base of the prism, then in that condition under that condition will get the whatever deviation that is the minimum deviation. And in case of minimum deviation one can also see that angle of this incidence and angle of emergence will be same,

here I have shown this angle of refraction here theta, that is half of the prism angle A by 2. And an angle of incidence is equal to the half of the angle of prism plus half of the angle of minimum deviation, from simple geometry one can shows this relation

And this according to the Snell's law and from there n refractive index n equal to sin A plus delta n by 2 divided by sin A by 2 importance of angle of deviation and the importance of angle of the prism one can see from here that if you know then you can find out you can calculate the refractive index of the material of the prism.

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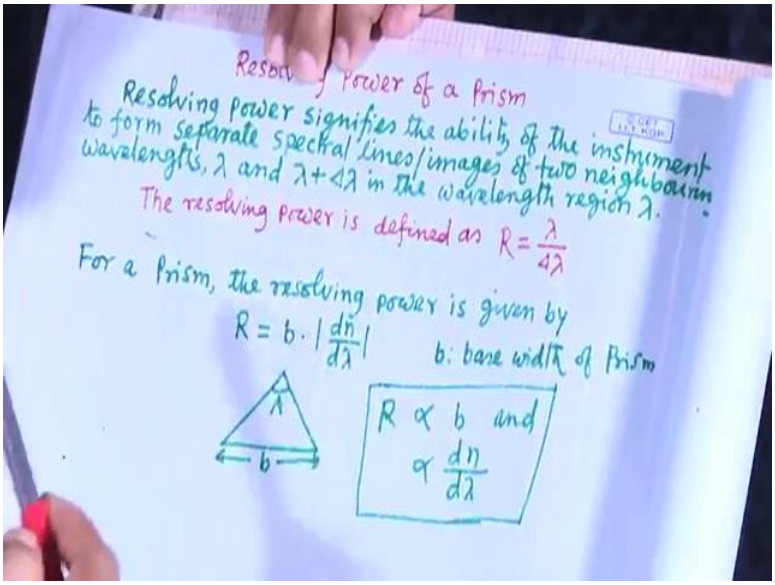

then next resolving power of a prism; what is the resolving power of a prism? resolving power signifies the ability of the instrument in this case our prism to form separate spectral lines or images of two neighbouring wavelengths lambda and lambda plus del lambda, in the wavelength region lambda, what does it mean? That if you have two very close wavelength lambda and lambda plus del lambda. If it passes through the prism according to dispersion dispersive power of the prism. this to ray we can see separately after reflection through the prism.

whether specially we can see them, we can separate them or not. that we define in terms of resolving power of the instrument and that is defined resolving power of the prism or is defined equal to lambda divided by separation of depends of the wavelength del lambda. there is the definition of the resolving power and for in case of (Refer Time: 23:40) the general definition, it can be for prism, it can be for creating for. Prism one can show that resolving power of the prism is equal to b, b is the length of the base into d n by d lambda n is the refractive index. change of the refractive index with the wavelength; this is the resolving power of the prism,

using this formula that has come from using the journal definition. one has to derive, and it is not very difficult to derive. these the dispersive resolving power of the prism, I defined I just revise the all terms whatever I will use for the experiment on the prism. next let us do experiment one by one, I think I will just demonstrate first experiments just in class. let me stop here.

Thank you.