Experimental Physics - II
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Lecture – 16
Determination of Focal Length of Concave Lens

Now we will demonstrate how to measure the Focal Length of a Concave Lens.

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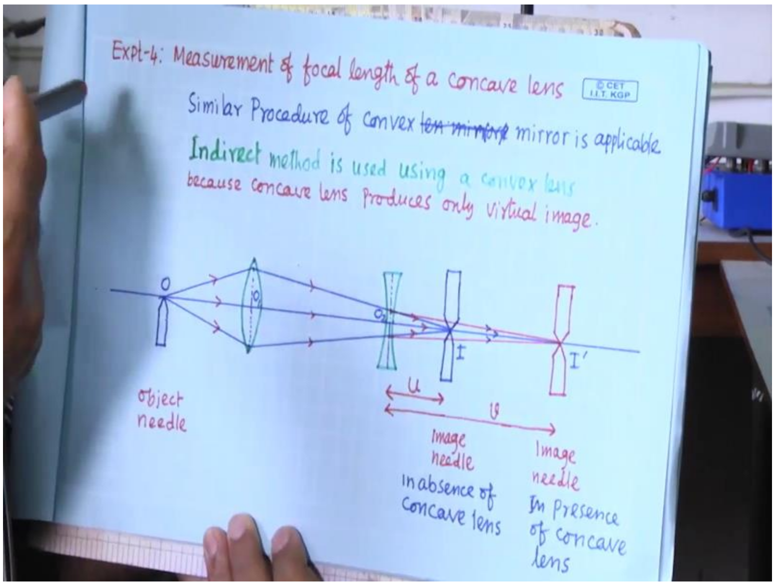

In last class I have demonstrated how to measure the focal length of a convex lens; now concave lens. Again, this procedure is similar; procedure is similar of convex mirror. In convex mirrors as we have discussed that only we can see the virtual image and erect image in case of concave lens also we can see only virtual image. directly we cannot measure the image distance. we have to indirectly we have to measure. we have to take help of convex lens as we took help of convex lens in case of convex mirror.

Here also this similar procedures as we have discussed for convex mirror. here; so, in last class we have measured the; we have measured the focal length of a convex lens. this is an object needle. then we found the say this is not there. this convex concave lens is not there. this we found we found the image position play image position putting the image needle here using the parallax method. this is the image; this is the image position for the convex lens and here also this we have put the object needle at 1.5 times approximately that distance from the lens. this is the image for this convex lens it's the real image and inverted one. Now, what I will do I will put the concave lens whose focal length we want to measure between the image of this convex lens and the convex lens. somewhere here between these two we will put this convex concave lens.

Concave lens is a diverging lens. whatever ray was coming and meeting here before this lens now what will happen? this ray will not follow this blue line. it will diverge; it will diverge from this part it will diverge from this part; that means, they will not meet at this position they will meet away from this position somewhere here. then this will be the image this will be the image for the combination of these two lens; for the combination of these two lens.

Now, if you think for this lens for this concave lens now for this concave lens this is the source; this is the source as if this light this is the object as if light is coming from here light is coming from here and then it's a diverge and they are forming image here ok; they are forming image here .

Then you can say this from this lens this is the object, and this is this distance is the u object distance and the image for this object image is this one. this distance is v. before; what we have to do? We have to fix this object needle and then we have to fix the convex lens at 0.5 times of the focal length approximately and then we have to find out the image position we have to take the reading of this image position. Now, we will put the diverging lens; we will put the diverging lens and then we have to find out the image position and we have to take the reading of this image position and the reading of this diverging lens that is concave lens.

Actually, we need the reading of these three, so then you can find out u and v. this is the one set of experiment data you can take and for these data. generally we take three observation to look at the image position and then take average of that one and then next what we will do second set of data we will take just we will change the position of this diverging lens, concave lens by two centimeter this side and two centimeter other side .

two more sets of data we will get for each position we will find out the image position. Then we will note down the position of these diverging lens, it is there already is noted down it is there. because as long as we are not disturbing these two. this image which is the object of this converging lens concave lens. this will give us the same reading only for these two different position we will get two different image position that we have to note down.

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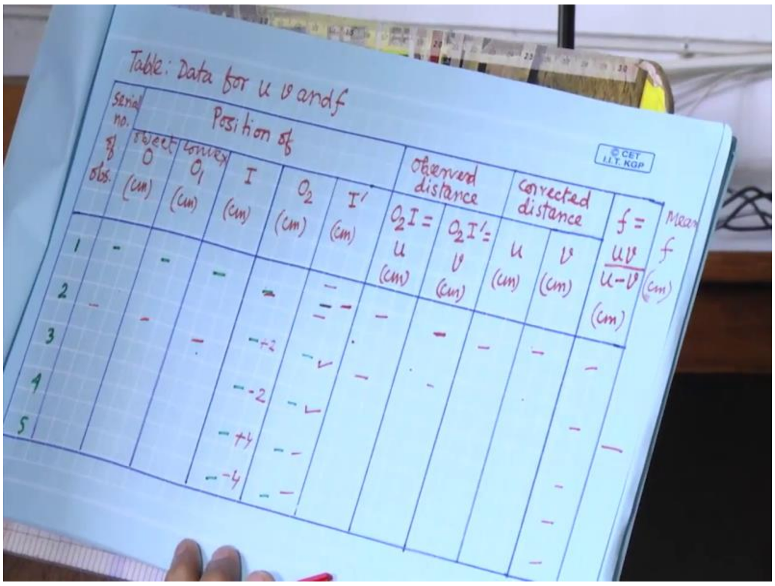

Unit table data for u v and you can find out f. number of observation and then position of O means this in this case O I have I have mention this is the object O means here object position, O 1 optical center of the lens which lens this is the convex lens O 2 is the this concave lens and I is the image of this lens convex lens and this is the image for the when you are putting this O 2 .

That is why I have I dash, so that location I had used here in the table. this is the position of the object I think better to write this object O ok object O position, and this is the convex lens position, convex lens position O 1 and then corresponding image position find out. Now, put the concave lens and note down the position of this concave lens and then find out the second image next image position. we note down generally as I mentioned that actually we can take three data and find out the one more column you can find. find out the average reading of this second image.

You will be able to find out for this u and v. Now, second set as I told this keep this fixed; keep this fixed convex lens also fixed, so this will be also fixed. Now, change this position this one whatever plus minus plus 2 and other set of data you can take minus 2 whatever this earlier reading was there and corresponding image this reading you find out this also you find out.

This way this is plus 2 minus 2 this now you can find out plus 4 minus 4 this on the original position plus 4 minus 4 this way you can take other two more reading; two more reading. you will get u v either three sets of data or four or five sets of data we find out calculate f for each set data and then average of this f will be your here another column you can make is a mean f ok; mean f in centimeter mean f in centimeter. find out the mean focal length of the divergence lens concave lens. this is the; this is the procedure. in last class already we have discussed how to find out the image position for a convex lens and then we will put the diverging lens. let me show.

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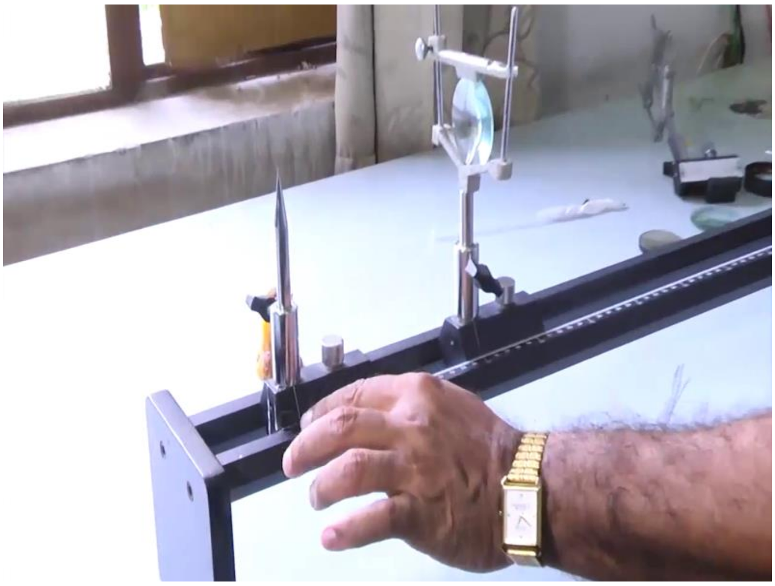

here same lens convex lens we are using say its focal length is around 10 to 12.

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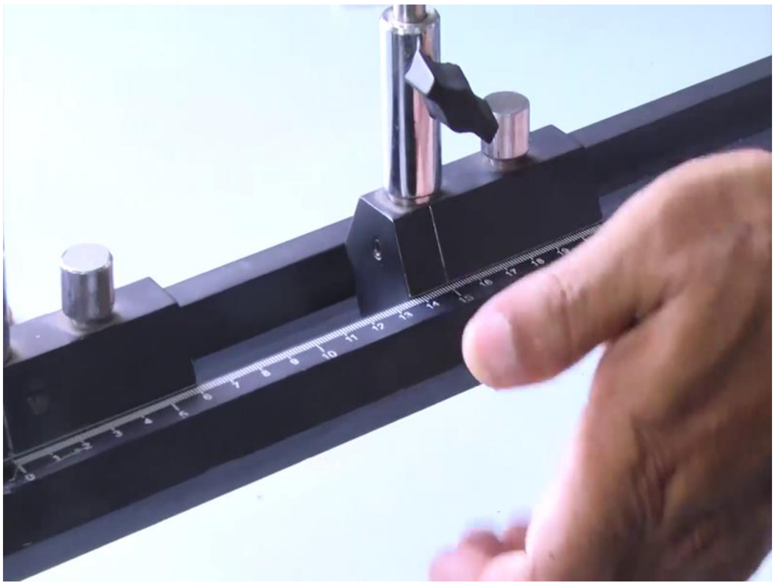

This object needle I put at 0 this one, it is at. say 15 let us keep at 15 and then we found this one is at around 64 something.

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I will keep the same one image I will keep the same image distance. this is the image for the convex lens this is the image for the convex lens.

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Now, I will put this is the; this is the concave lens we want to measure the focal length of this concave lens. now, I will put this concave lens between the image needle and the convex lens. let me fix it and then let me keep at a particular distance say I will keep at it is at 15.

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It is at 25 I will keep at 20 no let me keep at 30, let me keep at 30 and then plus minus 2 plus minus 4. that way you can do, or you can start from the say 25; you can start from the 25 and then take reading for say 27, then 29, then 31. this way you can take four five reading. this reading I have to note down right this reading I have to note down because this is the position for the position for the image of the convex lens.

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But this is the now this is the as if this is the object position of the convex concave lens. But actually, since object is it is here, so image will form here. I will noted down this reading now this one I do not need to keep it here right because that image real image, inverted image it will fall at this position the reading I have taken. Now, I have to find out the new position of the new position of the image which is image for the combination of this lens for this object or I can say that if this is the position of the objects for this diverging lens or concave lens, then that will be the image position of the diverging lens with respect to this object .

After taking reading if I do not disturb this object needle and the convex lens reading then just after finding out this image 1 this position 64.4. Now, I do not need to put it here, so I have to find out the new position of the image. I have to see through this lens, so let me take away and with bare eye let me check it its slightly yes, I can see now I can see; I can see. image will be away from this position that is the; that is the things image will be at this position earlier whatever 64 point. now, a divergence it will diverge, and it will be away from this position. I expect it is; I expect yes, but I am not able to see it let me. let me just.

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I was trying to set this concave lens keeping the position of the convex lens of the previous experiment ok, but what I of difficulties I feel that when I am putting the concave lens, then I am getting image faint image and it was difficult to see the image and remove the parallax error. what I have done now?

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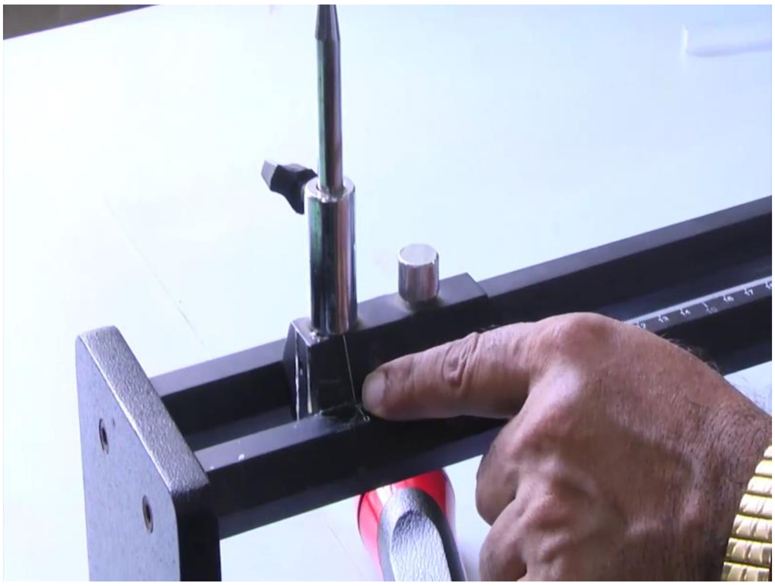

This is the original position of the object at 0. this for concave convex lens when we are doing experiment then I kept at 17 and also, I told we can keep 15 as well as 19. within f and two f I was it was kept and doing the experiment.

An image was beyond that wave other side beyond that wave. image distance was far away, and that image was the object for the concave lens. since the image distance was far away, so that is why the when we have seen through the concave lens then since it is from this original object it is far away. intensity is becoming very low and it was difficult to see that one.

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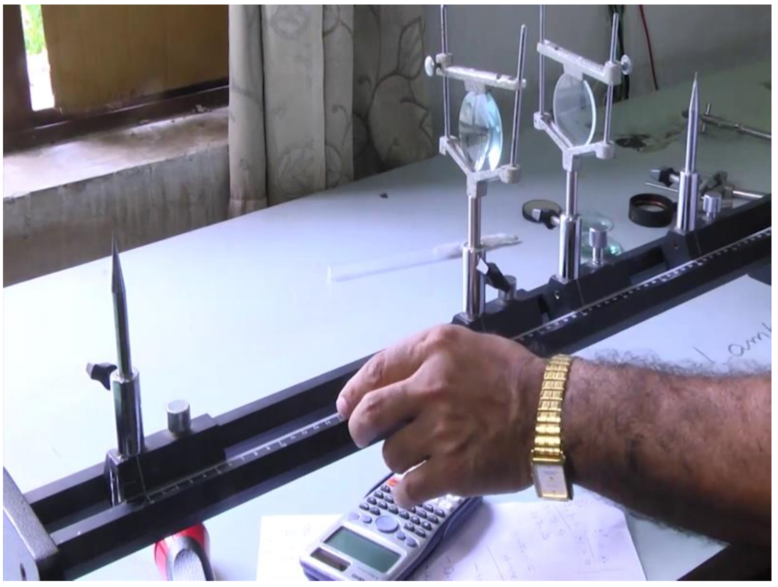

now I got the suitable position. if I keep the convex lens; if I keep the convex lens out of 2 f. it is f is say around 10 for this convex lens. if I keep it; so, 2 f is 20, so if I keep away from the 30. I kept it at around 30 and then so; that means, the image I will get within f and 2 f within f and 2 f.

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If I remove this one; so I have to I will find out the image position and it will be closer to the lens; it will be closer to the lens because now object distance is more than 2 f. image distance will be within if f and 2 f this is the other side. now in this way actually image I am getting closer to the closer to the than the earlier distance earlier it was greater than 2 f; it was greater than 2 f yes. it’s around I can say yes.

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It’s around say 51.8. this is the now this is the position of the image needle for this convex lens for this position when it is at 30. now, I will not disturb these two. this position I will note down its a 51.8. for this position this will be the image of the, this will be the object of the convex concave lens, so I put here. say I am keeping this one at say around 40; around 40.

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Now I have to find out the new image position. for the position of this one is 40 and now this I have to; I have to. now, this image new image will be away from this place, so it's a diverge. this divergence depending on these convex this lens focal lens it say around 20 concave lens. I have to find out the position of this one yes, it's a small divergence basically; small divergence small divergence. Yes, more or less this is the position; this is 59.

We have to note down; we have to note down. this is the u v data and f. of instead of keeping the same data as used for the for finding out the focal length of the convex lens. now, I have used different position ok; so, the image will be closer image will be closer, then for or putting the second lens I can see that one because it's a twice diffraction. that is an intensity will decrease. now, object distance, so it is a 0, convex lens it is at 30; it is as 30 ok, image distance it was at image distance I forgot something I got around 53 4 probably I got I forgot.

One has to note down that one and then now your convex lens position convex concave lens position here it is 40 you have to note down now image new image position where it is 58.67 or 8. you have to note down. then you can find out the observe distance and then corrective distance means if you have any index error. note down then you can find out the f. now, for different position of the mirror; for different position of the mirrors I find out the new distance of the image. keeping this other same; keeping the other same because the I am not disturbing this object original object as well as the convex lens so; that means, image; image distance this it will remain same.

Now, I am just changing the position of this one different position of this one and I have to find out the position of the image new image I dash and then I can get mode say sub data and then you can calculate the f find out the. here what I have learnt during doing this experiment. initially I was trying to keep the lens convex lens distance within 1.5 times of the focal length, but that for that position this image was distance was more than 2 f ok, so it’s a far away. then I was putting the convex concave mirror not mirror lens and then the image was going further away, so; that means, the intensity of the diffracted beam was going down and its I was feeling difficulties to see the inverted image and to find out the position of the of the image.

But if I keep; if I keep the distance of the convex lens more than 2 f; that means, that image will come closer it will come between f and 2 f so; that means, now this image distance it is image it is a closer it is closer to the object earlier it was away. now I will get better intensity and so after putting the concave mirror concave lens for a particular position between the; between the; between the convex lens and the image of the convex lens. I will vary the position of the concave lens at 3 4 5 distance 3 4 5 position and for each position I will find out the new image distance.

And because of divergence it will go diverge it will go away from the original image position which is the; which is the object of the concave lens. that way one has to take the reading of differences find out the main focal length. here trick is to find out the to remove the parallax. first we have to adjust the distance to coincide the tip of the image needle and the tip of the inverted image so; that means, you are almost in a position of the your needle is the position of the image position and then you have to just adjust the slight distance of the image needle to remove the parallax error. this is the tricks one has to apply.

This way one can find out the focal length of the convex mirror, convex mirror; it is easy for concave mirror. There is another method to find out the focal length of a convex lens;

that is called the displacement method and I will discuss in next class how to use the displacement method to find out the focal length of a convex lens. I will stop here.

Thank you.