Experimental Physics - II
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Lecture - 13
Determination of Focal Length of Concave Mirror (Continue)

Today I will discuss how to measure the Focal Length of Mirror, concave mirror and convex mirror. Let me demonstrate the experiment how to do the experiment, but unfortunately, I will not be able to show you the image of the needle, because capturing the image in camera, we are feeling difficulties, anyway.

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What is the procedure for doing experiment? take a mirror concave mirror for measuring the focal length of that mirror, so you must so these the holder of the mirror, so you have to fixed hold these mirrors. Now, this mirror is so we tell this is the upright, so it is a this is the ok; this is the holder of mirror this is on part and this we tell this upright.

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Here you can see there is a mark index, you tell index mark index line.

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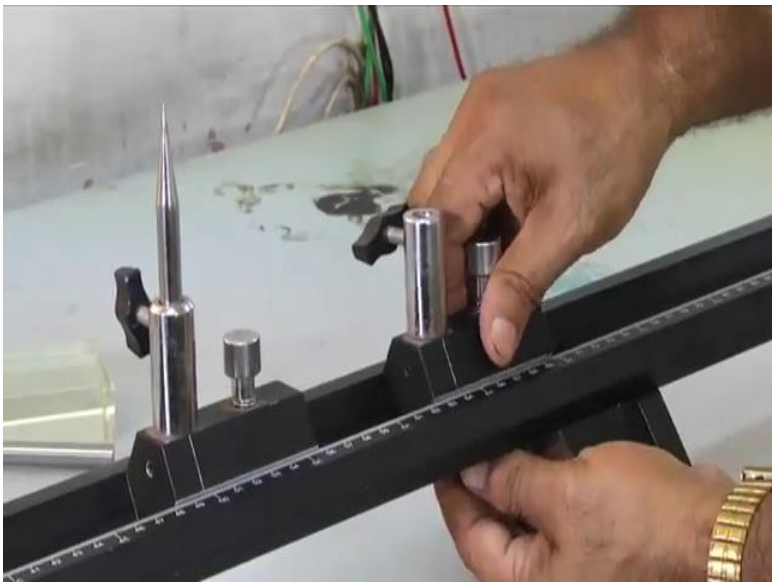

This line when it coincides with the where the coincide with the some reading on the scale, so that reading shall we note down. here so you can put this, and you can movingly, now when you want to fix it.

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Here I will show you, there is just press it and rotate it ok; so, then it will be fixed with the upright. press it and then you can rotate it.

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If I want to fix that the particular position, so here I want to fix it. I pressed it and then rotate it ok; so now you cannot move; now you cannot move. if you want to move, just release it and it will move.

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So that is what here I have fix the mirror, it is the I kept it at 0 position. reading of the mirror is 0. for the whole experiment to I will not change the position of the mirror ok, for this position of the mirror we will do the experiment.

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Now this is the object needle these the object needle, again this you see as I mentioned. with this we have put this needle, where I kept it yes. this can be on this.

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One must put this needle, I think I cannot put this so anyway, so this I cannot put, but this.

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Actually, base the needle ok, so this needle I put here, see so you can adjust the height, we can adjust the height fixed it. Now, put here ok, you can change the position, you can change the position.

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Another let me keep it here. now I have mirror; now I have mirror and generally you take it close to this and see the look at the centre, look at the I think centre of the mirror; centre of the mirror and see whether this adjust this height; adjust this height, it should be at the centre, it should be at the centre. actually, and this way you should see you know, it should be at the centre of the so I can see image, but I can adjust the height.

I can adjust height file ok; you can adjust height. I can see the image of the solve erect image, it's very close erect image I can see. Now, I am changing the position of the object needle, I saying the position of the object needle, then I can see these the erect image; now it is changing, it is changing its becoming defuse the image, it becoming diffuse the image, now its inverted you know, now it is inverted, now I can see the inverted one.

Focal length is it's at this around this point it will be focal length. now I will keep the distance slightly more where I am, initially I am getting the initially I am getting the inverted image clear image, inverted clear image when I am getting yes. I think I must reduce slightly height, so it looks, because now inverted it has gone down, yes.

Needle tip I am putting at the middle of the mirror ok, yes. yes, clear image I can see when I am rooting moving further and further, I can see the image of the tip of the needle, yeah further these. it is the so approximately this focal length of this mirror you

can see. I found that it is a around 16, because it is the invert, it is just erect to inverted it is the just when its erect inverted.

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When reading is around yes, around 20 also. it is approximately this focal length of this mirror will be around 20, so plus minus some this is just this is approximate. I must keep the keep the distance, I have to keep the distance of the object will keep between f and 2f means, between a focal point and the at the point of ready centre of curvature 2f c.

If it is 20, so this will be around 40. say let us let me keep it at say 25 ok, I will keep it at 25. Now, keeping at 25 I will fixed it, I will fixed it ok, so that there should not be change of this position of the object. Now, look at the image of this inverted image to the mirror. Fine I can see, but unfortunately, I cannot show you yes, I can see, now what is the task, so I will take image needle and put here.

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Image where will get image? when this object is at f – focal point, image you will get at infinity. When this object is at 2f means at the centre of curvature 2f distant, so you will get the image at the same point. now when that means, when you are increasing the distance of the object from the focal point ok, towards the centre of curvature when you are moving.

Image from infinity to it is coming to the centre of curvature that means, from focal length you are increasing the; increasing the; increasing the distance of the object and going towards the centre of curvatures. image will form image will form behind the; behind the centre of curvature ok, it will form between infinity to curvature.

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I can guess that where I can get the image approximately, anyway. now this also you must make this of same height, it is the more or less same height yes. here what you will see this image of that one also you will see, but if do not concentrate on the image of this one ok, you concentrate, or they tip of this real this image needle. And look at the tip inverted tip of the object needle.

Now this object needle, object image of the object needle and the real this tip of these image needle. they will so you have to concentrate the tip of these two; one is image needle tip and another one is image tip. now procedure is you must change, you have to change the position. you have to; you have to first I will take it out and first I will concentrate at the I will look at the tip position, I think yes inverted tip position of the object, Tip position of the image, I can now I set my eye in such a way; so it is at the middle of the; middle of the mirror. Now, keeping my eye at this press, I will put the this is image needle.

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Now, I will set my eye in such a way, so this tip of this needle image needle and the tip of the tip of the image, they are on the same line. Now, what I must do is the parallax method. I will close my left eye and open my right eye and I move my; I move my head left and right and I must see that this both tip at which for which position of the needle, object needle this image needle.

They are moving together they are not detach, but now they are detached, they are detached. Now, I am putting here is coincide, but they are detached, so I must find a position where they will not detach. they will move together, no they are no I must go away it is expected, because my object position near the focal length. image will be far away from the centre of curvature. If I move, move no, no, yes sometimes you have to you have to this ok, yes.

Do not see the image of this one. you must concentrate you are this point and the image of this one. I can see their moving together almost, they are moving together ok, so one must find out, but they are the slightly we have to adjust the mirror; angle of the mirror slightly, but I will not disturb, but some its ok, so yes.

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I have to change I have to change and find out the yes, no, yes you know you know their detach, no, yes their moving, I am close to that ok, I am close to that you knows I think I have to either yes, its yes. more or less I found the position. these the image needle and the image tip are coincide at this point, so these the image distance. you must note down we have to note down the you see.

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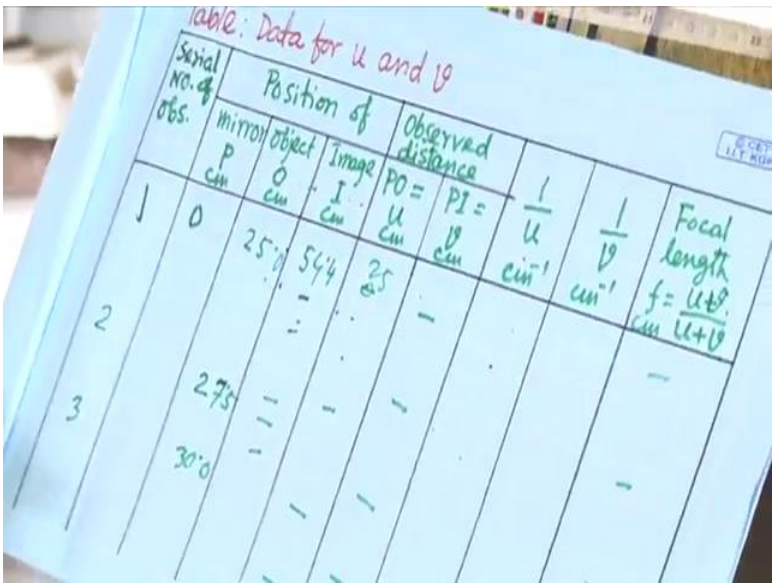

Observation number 1, what is the mirror position, so P it is the 0 reading. Here what is the position of this needle this object needle, so this 25. And then by parallax method, we

found the position of the image needle and its reading is I can see 54.2, it is the 54.2 ok. what you should do, you should take so this generally what we suggest, you take this reading three times; you take this reading three times, again you have just and take the reading ok, fixing the keeping fixed that one. then whatever you will get, whatever you will get, so you can take average of that is in table I have not put, but you can take average of that one or for each one, for each one you can find out the; find out the u and v.

I think it take the average of this one. And then your PO will be, so different between the say here I think direct reading will be the PO note down. Here whatever the average you will get for this three reading note down, and we will be not 54, it will be 25; it will be 25 ok, so that is fixed.

Now, for image position you are adjusting ok, taking three reading and take the average of that one, so that this minus 0 that will be the it is not necessary to keep it at 0, but it will keep at 0; say is the advantage, it can be other reading also. these are the calculation. these the first observation for a mirror for a particular object distance.

Now, I will go for second observation. For each observation for second observation in the sense of for second distance say, I will keep this one, say 20, say this is the 25, then you can change by 27.5. And again, find out the image position and take this the three times this reading takes the average of that one. similarly, observation three you take for the say 30 right, better writer 25.0, 30.0.

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Change the position of the object by 2.5 centimeter. And for each position you, you find out the; you find out the position of the image needle. How to find out that I explained you, so for each you object distance, you must find out the image distance following the method as I described. we will get data for different u, you will get data for different v.

Then you can calculate f, you can calculate f and you can take the average of the f of that will be the focal length of this. which I one can find out, another way you can use graphical method to find out the focal length, so that I will describe. two (Refer Time: 22:27) is you can plot graph, one is u v graph ok, u v graph; in x axis you can plot you and y axis we can plot v. from u v graph you can find out the f, how to find out I will tell you. Also, you can plot 1 by u verses 1 by v graph ok; from there also you can find out the f.

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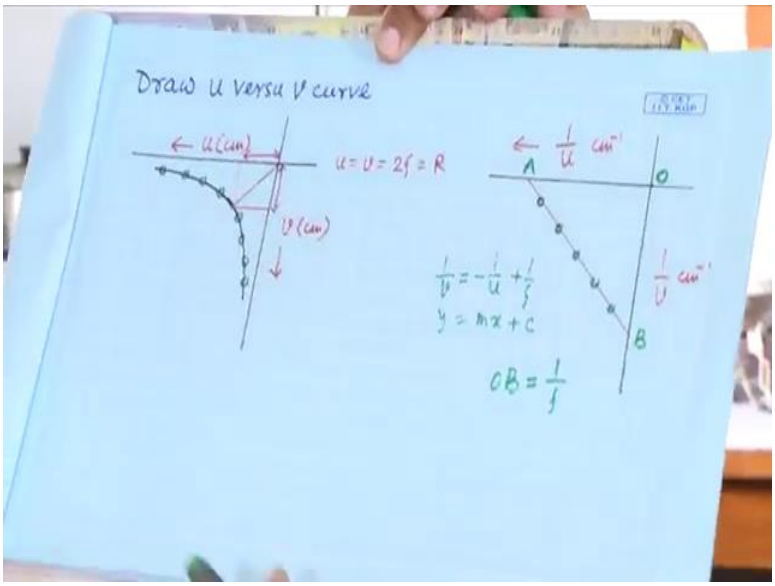

After taking data u versus v, you can calculate 1 by u versus 1 by v, draw u versus v curve. here since in case of concave mirror u value and v value both are negative, so that is why these the x axis, so we have plotted in the negative value direction ok, negative direction. And this also v negative, so y axis these the y axis, these the x axis; so, the negative x, negative y.

Now choose the scale and plot your data u or different u, what is the v value. Now, it will be curve like this ok, now here how to find out; how to find out the; how to find out the focal length from this curve. we must consider the fact that you have to consider the fact that the point on this curve you will if you get a point on the curve, where u and v value are same.

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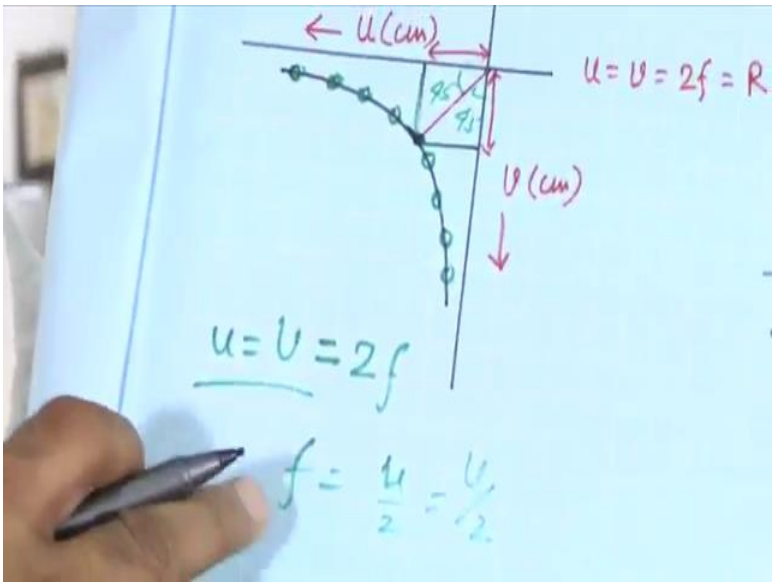

When u equal to v, when u equal to v, it is only possible when image and the object both are at the centre of curvature at c. from the center if you draw a line at 45 degree; at 45 degree ok; at 45 degree ok, where did you meet here. for this so this point will be basically, this point will be the point where u and v value will be equal.

And this value centre of curvature, what is the distance from the mirror, so that is 2f. here whatever, so from this graph itself drawing this line at 45 degree you can find out this point, now what is the u value and what is the v value we can find out ok, so that equal to 2f. f equal to we can either u by 2 or v by 2 ok, you can calculate the f from this curve.

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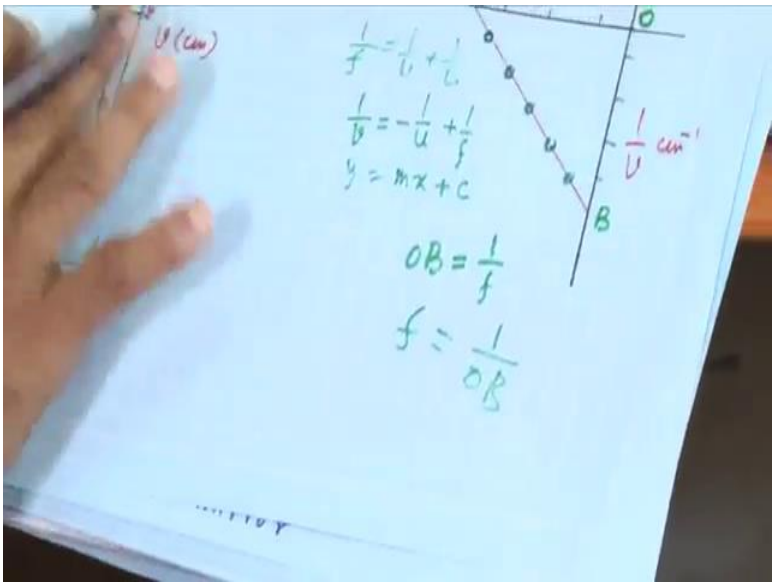

Another way, this we can plot 1 by u versus 1 by v, again these are negative, so negative axis we have chosen, negative axis we have chosen. you could plot 1 by u versus 1 by v, so you will get a straight line. 1 by v equal to 1 by u plus 1 by f minus 1 by, because 1 by you know this 1 by f equal to 1 by v plus 1 by u. 1 by v equal to 1 by f minus 1 by u, so minus 1 by u; so it is the just y equal to m x plus c. m is 1 minus 1, negative slope, this curve you will get straight line you will get is a negative slope. And c, c is the intersection of this line on the y axis. intersection is O B right, this is the intersection point, so O B is the intersection.

Plotting this 1 by u versus 1 by v curve, you can find out the intersection of this line, intersection of this line on the y axis, so that is so they, then you can find this length of this O B from these, because these are some scales are there so for drawing graph, you know. what is the value of B or this O B, so you can find out. these the these the c value, c value is c is nothing but it is 1 by f, so O B equal to 1 by f; O B from the graph we will find out, so f equal to 1 by O B. this way we can find out the focal length of the concave mirror.

I think I have described in details, how to do the experiment and how to find out the image distance. In next class I will discuss about how to find out the focal length of the convex mirror; also how to find out the focal length of the lenses: convex lens, concave

lens. Procedures are more or less similar. I will show, I will demonstrate in next class, so I will stop here.

Thank you for your attention.