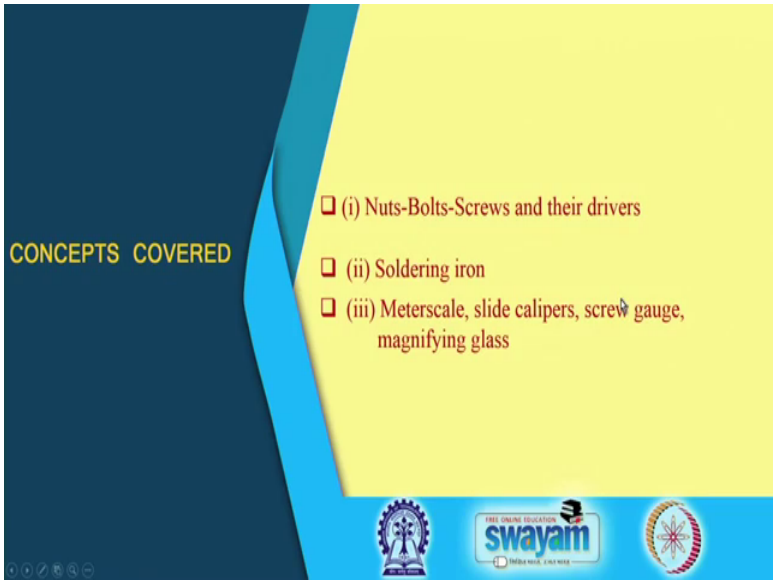
Experimental Physics I
Prof. Amal Kumar Das
Department of Physics
Indian Institute of Technology, Kharagpur

Lecture - 02
Basic tools and apparatus

So today we will discuss about the Basic Tools and Apparatus in laboratory.

(Refer Slide Time: 00:33)



So, basically concept covered in this lecture; will be basically we will discuss about the nut, bolts, screws and their drivers, then soldering irons, then meter scales slide caliper screw gauge magnifying glass, how this tools are used for measuring length so, that we will discuss in this lecture.

(Refer Slide Time: 01:07)

So, if you go to lab and then you will find out different types of nuts, bolts, washers, screws, nails and their drivers means to screws or to bolts this. So, what are the instruments are required to do the job. So, these are basically its a called this wrenches, then Allen keys then screw drivers ok. So, just I want to make you familiar with these tools, so basically this from my lab. So, whatever I am showing here this is from my lab, so I have also brought these items to show you online.

So, let us see one by one say this called type of screw, it see it is a these are screws.

(Refer Slide Time: 02:26)

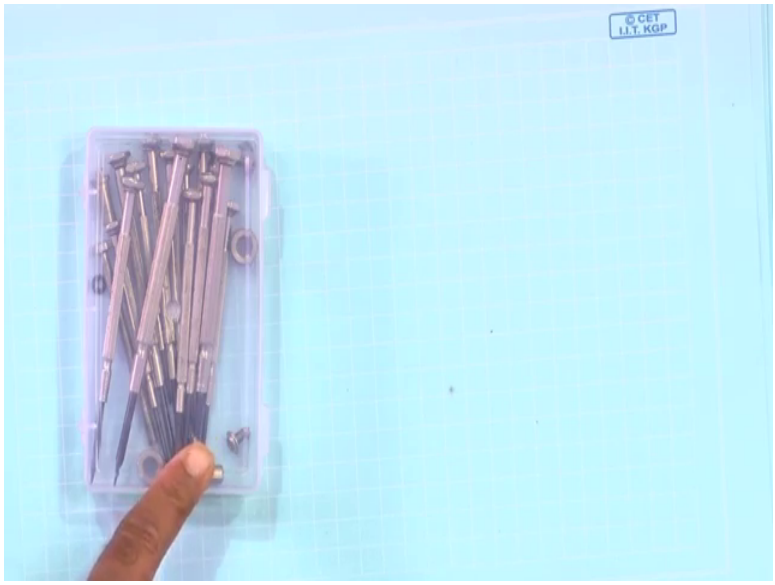
So, this very a small screws we have bigger also, we have bigger also say another types this is different. So, this one I think nut these basically a screws now what is the difference between screws and bolt so, that is I will tell you. Then I have this is another type. So, they are various kinds of nut bolts screws use in lab and these basically nuts. So, whatever I have shown in picture. So, all from my lab and that is what I showed some of them to you.

Now, just let me tell you about the difference of this words nut, bolts then screws nails ok. So, here if you see in this picture, so we see. I think these are these are basically here we have bolt, these are nut no these are nut and this is the washer, this is the washer. So, I think I can use pointer. So, these this is a washer like that I think that will not. So, this is the washer, this is the bolt and this is the nut right. So, there has the washer of various kind of washers are here, nuts are here. And these are basically one of bolts these are bolts. And these are screws see difference between the bolts and screws all are threaded both of them are threaded, but difference is that this edge of this one and this is sharp. So, it can penetrate. So, if you put in wood or some soft metal. So, it can penetrate into that. So, that is why its a different from these bolt, bolt this end is flat bolt this end is flat ok.

So, this is the different between the screws and bolts and nut of course, these are the nuts and nail. These nail you know this nail is a in house also we use of this carpenter they use this nails. So, there is the thread in this nails and this edge is sharp ok. So, using hammers generally you can put this nails into wood ok.

So, these bolts again there are various kinds if you see the edge of this bolt head of this bolts you see this header is a hex is called hex bolt; and these heads are this differ then this one, this is also hex. Now to you need different tools for these two type of heads. So, that I will show different drivers for this to deals with this different heads of the bolts and of course, screws also. So, there are different kind of here I have shown different types of tools means drivers basically. So, screw driver these are this is the screw driver, this is the screw driver, here I have sets this screw driver ok.

(Refer Slide Time: 07:08)



Here you can see this is the screw driver ok. Now screw drivers this end is different its a some of flat some of star kind of things. So, for different type of head we need different type of end of thees screw drivers. And this screw driver this sets is generally some kind of people tell the jewelry screw driver.

(Refer Slide Time: 07:43)

So, another type of screw drivers are there. So, this is a very frequently it is used very frequently using here you see this is the star kind of edge star kind of edge, and this is the different; so to trick out the nail. So, one can use this set, this screw driver. So, some are

you have flat edge. So, from different edge basically you need different type of screw driver.

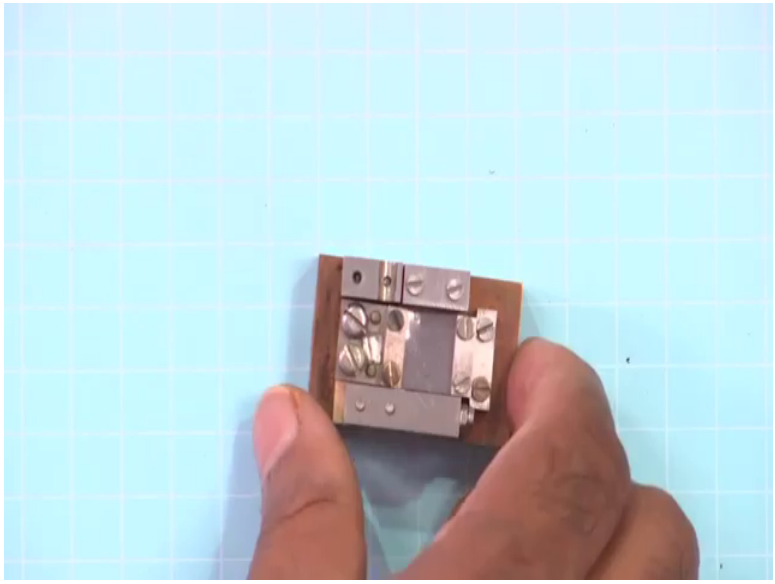
So, these are the common tools for laboratory one should. So, we should at least we should know the name and what are the thing available. So, you can demand for when you need to use you can demand this kind of tools in the laboratory.

(Refer Slide Time: 08:39)

So, this is the wrench various kind of wrench also whatever I have shown in picture. So, it is the basically its from my lab. So, we frequently use this wrench. You see this all are basically for of different sizes of bolt this is head as well as this is for or you say where you are putting them. So, depending on the geometry of that place so whether you will use this one or that one so, that also another factor.

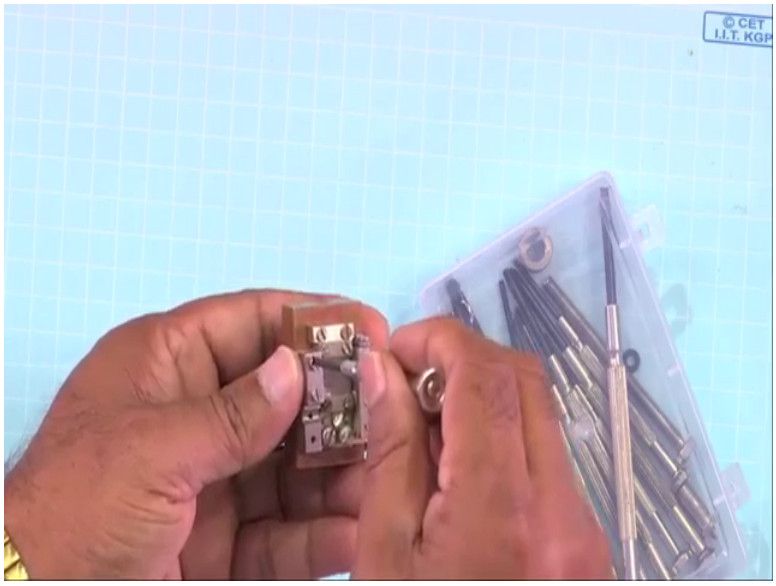
So, I think if you know these type of instruments are available. So, this use of them you will see in our lab also, when we will demonstrate some experiment sometimes we will use the some of them. So, these are the basic tools for the laboratory and you should know the name of them, and slowly you should try to use of them also. So, just I will show one use of them to you. So, here say I have I think this is another box can be give me. So, I have one capacitor and this yes. So, I will show you one piece of a you see this one.

(Refer Slide Time: 10:17)



So, this is a its a. So, there are many small pieces are there and this here also we have use this bolts, sometimes bolts and screws we confused ok. So, it is smaller bolts. So, then we (Refer Time: 10:43) screws. So, these we tell (Refer Time: 10:44) screw, but its a in principle it should we should call it bolt because its edge is not end is end edge is not sharp. So, if you want to open this one. So, you have to choose proper right this screw drivers it is like screw drivers. So, I need flat one and smaller one also.

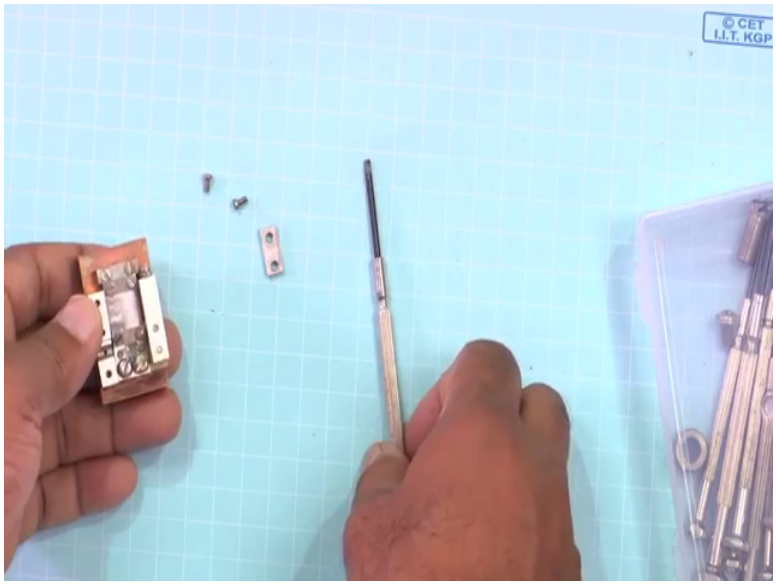
(Refer Slide Time: 11:16)



So, if you want to open this piece. So, just I think this is the right one. So, I can use it yes I can use this.

Now, when you leave we see I will not open one screw first. So, there are two screws I will not open the one first and then the second it is not that. So, both simultaneously I should open. So, I think this I can separate this pieces ok.

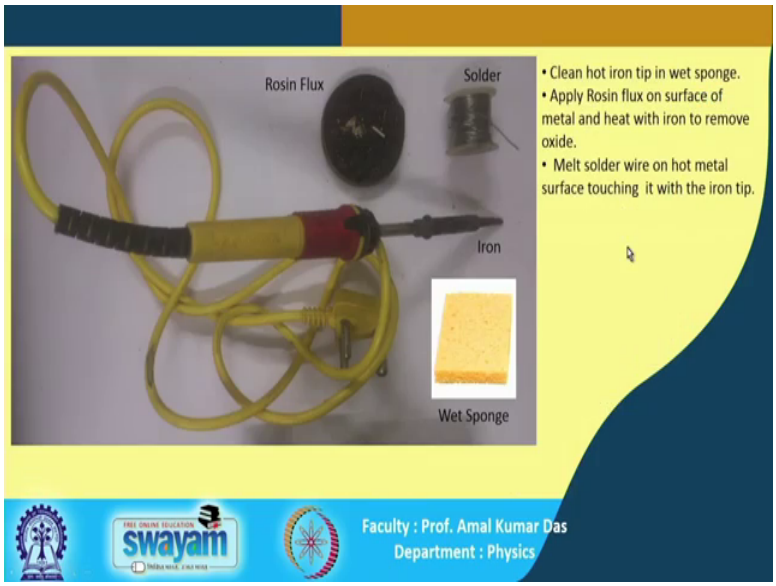
(Refer Slide Time: 11:58)



Now, this piece I have taken out. So, this is the screw see small. So, that is why we are telling screw, but we can tell also bolt. So, this is the piece we attached with this using this screw. So, this is the use of screw driver and this screws. So, this is just I showed you where we use of this tools. So, later on what is the use of this one? So, I will explain to you. So, right now I think this was some physics behind that one. So, it is related with some experiments; so that I will discuss later on when I need.

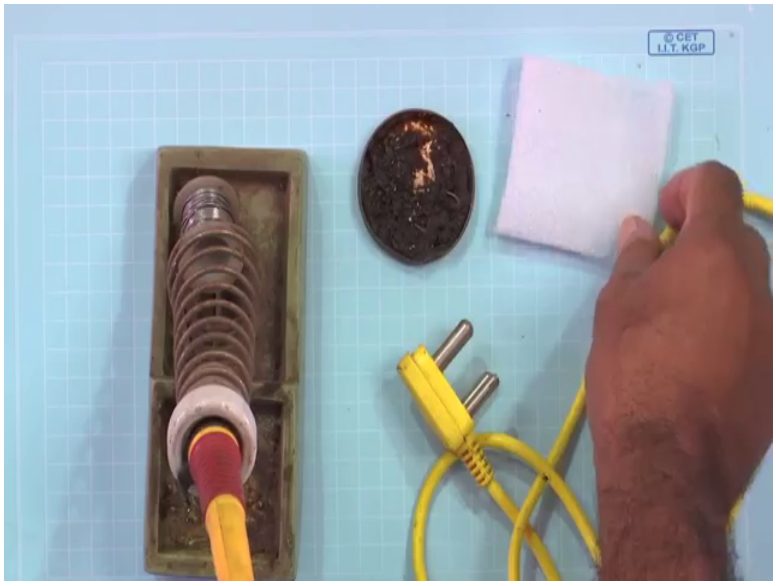
So, I will proceed it this basic tools and apparatus at the movement.

(Refer Slide Time: 13:04)



So, then if I go next tools so, that is basically very important for the lab; that is what is called soldering iron right. So, you have seen in this soldering iron in lab. So, you have to know how to use it. So, at least you should know the name of the different parts. So, here you can see this is called iron, these called solder and this is this sponge kind of things its a we tell wet sponge and this is the rosin flux. So, these four main items this is a set of soldering iron.

(Refer Slide Time: 14:10)



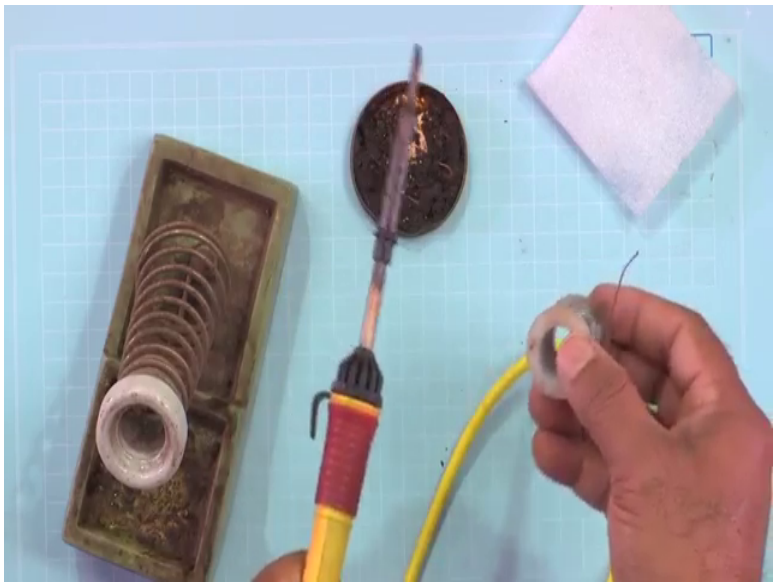
So, if you I can show you. So, this is also again from my lab, it is again from my lab; so its looks very dirty, but because we are using them. So, this is the rosin flux, this is the rosin flux and I have different colors of this soft sponge.

(Refer Slide Time: 14:29)

So, this soft sponge basically if you look at this edge of the iron see its very dirty really. So generally, I will not heat here. So, later on probably we will use it and you will see how to use it. So, basically first we have to clean this edge and this after. So, you have to plug in, and then after becoming hot this edge. So, we just the space with the press with this with this wet sponge and then it will be cleaned.

So, after cleaning now you want to solders you want to solder, what is that solder that I think it is here.

(Refer Slide Time: 15:21)



So, its the solders this is the solder, it basically the wire of earlier people used to use led. So, its a thin led or nowadays it is a thin silver this is the alloy the soft melting point.

So, when we will solder. So, we say solders some iron with I can show you say you want to solder these two pieces say these two piece you want to solder.

(Refer Slide Time: 15:58)

So, these two piece you have to hold you can hold with some instrument you can hold some instrument.

So, now actually you have to. So, this should be hold ok. So, I think this say two resistance two resistance I can I want to solder it, I want to connect them. So, this way and then you can hold it, you twist it first and then. So, what we do? So, this wires. So, what we do this just two is either you can take this solder material on tip of this iron or then we can put here. So other way, you can heat this wire and if you touch this solder I wire. So, this wire will be melted and put on this.

Now, what is the use of this rosin flux? This basically we if it is oxy oxide oxidized sometimes these two wire we have taken. So, they are they are oxy oxidized. So, if you want to. So, you have to remove this oxidized oxide part. So, there we apply this rosin, we apply this rosin and then we heat it then we heat it using the iron and then this rosin basically it will take out this oxide from this wire, and after that then you can again solder it using this solder wire, as I told just heat this wire and touch with this solder wire solder wire will be melted and put on it ok.

So, it will then you will get the good contact of this two say here two resistor. So, this is the use of the solder and probably later on you will see, how we are going to use, but at least you should you should be familiar with this type of tools in laboratory generally frequently we use ok. And this stand also important because its you cannot keep it on top of table or wooden table or on paper. So, when it is hot. So, you have to keep here. So, it is in safe position; so this is because of this stand also important.

So, this is the basically introduction by about the about the soldering iron and it is very very useful in the laboratory, generally our student dont use much we dont allow them to use, because one has to take precaution because it is hot.

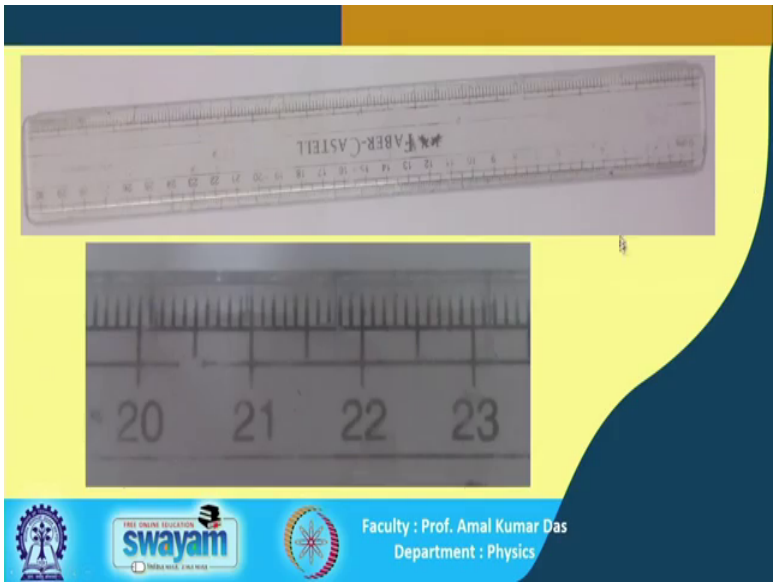
So, but you should need you need proper training to use it and you should use. You should use because if you because these are the basic apparatus. And you should not have any inertia in using of them, if we are become familiar with these basic tools and if you are train to use them. So, in future it will help you to take any project kind of things where you can think you can think of designing a new kind of experiment new kind of apparatus.

So, if you think to design see one is readymade instrument somebodies preparing for you, everything ready you are going and taking that is what you are doing most of us we are doing. But here in this course I will try to convince you this to perform the

experiments in other ways in different way so that you should not have any reservation, any inertia to take project new kind of project.

So, next important tools or apparatus in the laboratory very simple one so that is the meter scale.

(Refer Slide Time: 21:04)

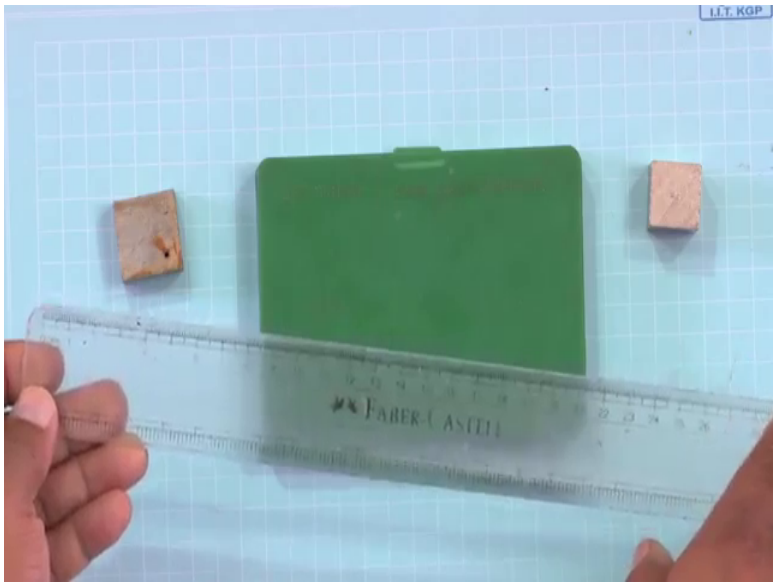


So, meter scale also frequently we used in laboratory, but this now why I am showing you why I am telling because, measuring length in laboratory is the essential part is the essential part of many experiment. So, you should know how to use the scale how to use the scale to measure the length accurately ok. Also here I will discuss about the significant digits when you are recording the reading. So, what is the significant digit, what is the doubtful digit doubtful figure so, that I will discuss in this scale in this case.

So, whenever you are going to measure a length. So, you need tools. So, this meter scale is a very common tools other tools are there. So, that is slide calipers and screw gauge. So, I will discuss now about these three tools how to use for measuring length. Say you have to measure say you have to measure one measure the volume of a rectangular or a regular shape item.

So, I can show you here..

(Refer Slide Time: 23:03)



So, I think say if I ask you find out the volume of this rectangular box or you find out the volume of this volume of this square shaped body or this rectangular shape another piece of body, ok if I ask you to find out the volume of one of them. So, what you will do? So, you will take the meter scale, you will take the meter scale I think I have meter scale same meter scale as I have shown you in the picture its not good one, but we can use it. So, here basically in meter scale it has two scale in centimeter one scale and another scale in inch ok. So, we will use this centimeter scale right.

So, now, if I want to find out the volume of this box; so this is rectangular box. So, we know this volume is equal to basically the length, breadth, length into breadth into thickness right into thickness ok. So, basically I have t measure the length, I have to measure the breadth and then I have to measure the thickness right. So, here this is the bigger one ok. So, I can use this centimeter scale meter scale.

(Refer Slide Time: 24:48)

So, now to start measuring this one; so first one has to do for you have to find out the least count of the scale of the scale. So, least count obviously of the scale you can in pictures, you can see here. Least count of the scale is basically see this is the 20 and this is the 21. So, in between there are 10 divisions. So, this is a one centimeter and in that 10 divisions are there. So, one division is basically each this line is basically each division is one millimeter.

So, this least count of this scale of this tool is basically this one millimeter right. So, that we have to first note down and then we have to we have to measure, second important thing is you have to measure you have to measure the length ok. So, then the one side I will this is a 0, this side this side I set at 0 and then other side some readings are there. So, you have to take reading.

Now, remember that whenever you do experiment. Then we tell always we tell you should take not only one reading you should take more than on reading and then take average right. Why now you have to think why we should take more times of more times the reading what is the necessary of that one? So, that you have to understand. So now you will take 2 times of 5 times of 4 times or 3 times. So, that you have to decide. So, generally we tell student you take three times this is the routine wise we tell, but this is not the way to tell or this is not the way to do it.

So, whether in this case now we tell me that whether I will take three times or two times or five times. So, there should be reason do I need how many times I am taking ok. So, here I will tell you to take four times, length measurement you take four times why? So, there are four edges see length this one edge, this is another edge, this is the third edge, this is the fourth edge.

So, I can tell you that is edge wise in four there are four edges. So, you take the length in along the edge. So, there are four edges. So, you take the four times you take this reading four times. Breadth also you take the four edge, because there are four edge. So, this I say I am taking four times reading and then I will take average of this four. So, why not five why not three it is four because there are four edges ok.

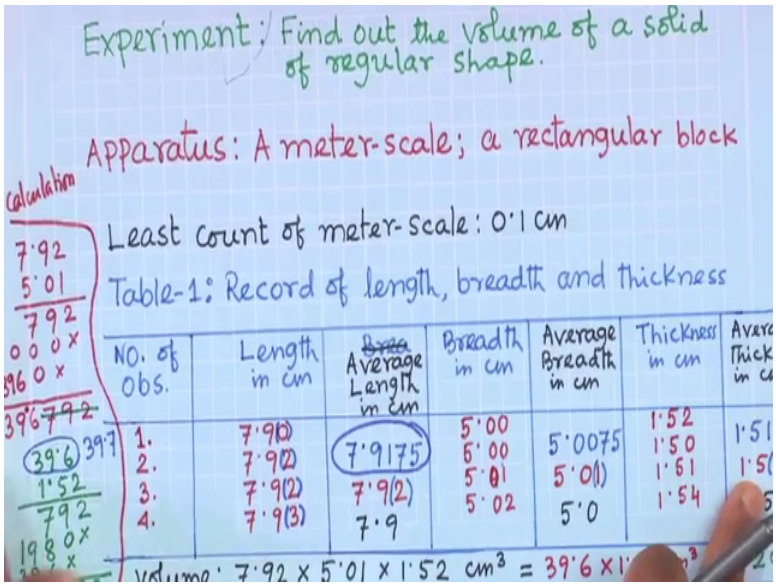
So, it is and why we are taking four times one is. So, there are some may be that this length of this length may be different. So, its may not be perfectly rectangular ok. So, that is why we should take average of these four edges. So, that is why we are taking four times same reading four times ok. And if you take a wire say you are measuring the thickness you are measuring the thickness sorry not thick radius or diameter of the wire, then we tell that you take few times why? Because this wire diameter along the length it may not be same.

So, we should take the average. So, that is why we take three or five times that different position depending on length of the wire ok. So, you have to take this side. So, it is compulsory that you should take you should take few times this reading now how many times you will take? So, you have to decide it is not that teacher will tell. So, five times you should take. So, for all experiment you are taking five times. So, this should not be the things it is there should be reason why you are taking 3 times or 5 times or four times. So, as for example, as I told you here in this rectangular box, we are taking four times reading because there are four edges ok. So, that way we have to justify where you are taking few times the same reading, so that we have to justify.

So, I will take say along the four edges, along the four breadth, along the four edge of the thickness here you can see this four edges of thickness I will take.

So, if I measure. So, I will show I have measured not this box, but for another block. So, I will show how to take the reading and write them and then analyze.

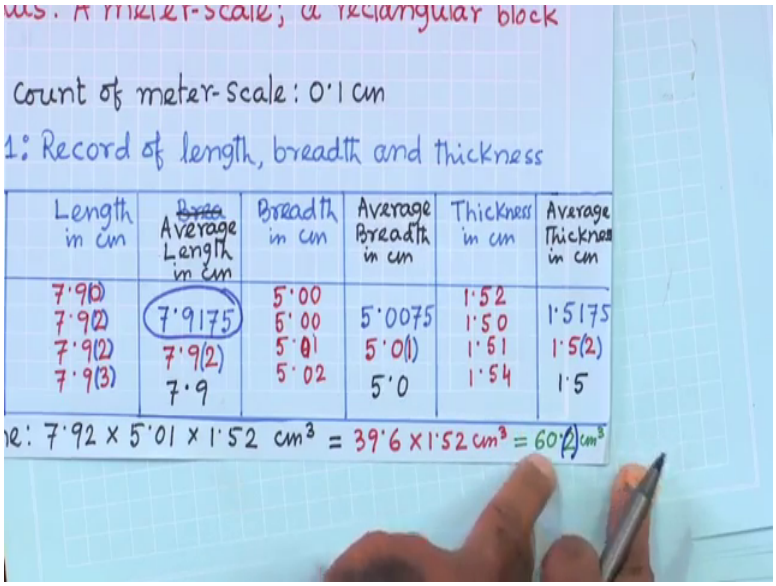
(Refer Slide Time: 30:14)



So, if we see it here say here say experiment, using the meter scale find out the volume of a solid of regular shape. So, I have say for that apparatus you need meter scale and a say rectangular block. So, first as I told that you have to find the least count of the meter scale ok. So, that is 0 1 millimeter means 0.1 centimeter.

Now, you have to measure the length breadth and thickness. So, you can make a table; and in that table what would should be the column? This number of observation and then length what is the unit? In centimeter then you are taking four times as you have decided of as I told ok. So, four times we will take this reading in for length and then we have to take average length find out average length. So, this is the average length I will explain and then breadth reading you have taken in centimeter, thickness reading you have taken centimeter ok.

(Refer Slide Time: 31:26)



Now, for reading I have taken ok. So, here first reading for length say if I explain one. So, other will be similar. So, here I have written first observation 7.90 centimeter ok. Then next one I have written 7.9, third one 7.92, and then 7.90 now here question is that list count is 0.1 centimeter.

So, whether I should write 7.9 or 7.90 both are same is its both are same? Reading wise this is same, but we see error does it has significant this digit has significant. So, 7.9 and 7.90 are not same. When you are writing 7.90 you are demanding basically the accuracy up to this last digit you are demanding accuracy up to 0.01 centimeter, but your list count is zero point one centimeter. So, you should not write 0 you should write 7.9, but you can write 7.90 and then measure up to second digit decimal you can write. So, then this last digit the second digit the second after decimal second digit this is called doubtful figure doubtful figure ok.

So, you are writing up to second digit. So, then 7.9 is the accurate accuracy it has accuracy 100 percent and then 0 this is doubtful. Because the meter scale you know in meter scale. Here you can see this between this two line its the 1 millimeter, but you have scope to guess that if this some reading is between this two line. So, we can guess it is 55, it is in middle or it is slightly left to the middle or slightly right to the middle.

So, you can guess one millimeter even you can you can divide into 10 division ok. So, then you can guess it is 0.02 0.05 0.07. So, that type of basic you can do, but its not

accurate one it is the doubtful digit. So, that is why here up to second digit I have written, then this digit generally we write in bracket we write in bracket, this digit we write in bracket to show that to tell that this is the doubtful digit, but this reading 7.9 this is the accurate reading as per least count of these tool, and this second digit we its we guess this digit this in this measurement and this is the doubtful digit.

So, doubtful digits either we have to we have to mention either its a boon later or it is in a bracket we have to we have to tell this accuracy up to first this up to first digit after decimal, second digit we can this is the guess reading that is the doubtful digit fine. So, now second part is the calculation. So, you have to find out the average length average length. So, if you add them if you add them. So, it say a 7.9 it is there in all is 7.9 it will be there; now here, this second digit so, 322 meant to 7.

So, if we divided by this four 0.07 divided by 4, then you will get 175 right 7.9175. So, if you use calculators calculator we will give you 7.9175 ok. Now question is whether you will write this one? Now again if you write this one; that means, in length measurement you are demanding you are demanding this accuracy up to fourth decimal you know; up to fourth decimal you are demanding means 0.0001, that is the accuracy least count of your instrument but this is not the case. So, here is I can write 7.9 and then two here one is there ok.

So, one is followed by 7. So, if it is 5 or more than 5 generally we increase by 1 ok. If it is less than 5 then just we leave it. So, here we one can write 7.92. Now two in bracket I have put this is the doubtful digit as my instruments accuracies 0.1 centimeter. So, this second digits second figure will be doubtful figure. So, you cannot write this one, you cannot write this one either you have to write this or you have to write this 7.9

Similarly, for this breadth also one can calculate. So, from this measurement actually I am trying to tell you the importance of the least count. I am trying to tell you the how to write the after calculation after multiplication after average after division whatever result you will get. So, up to which the figure it is significant, which figure which digit is doubtful. So, that one has to understand and that is what I have taken this example.

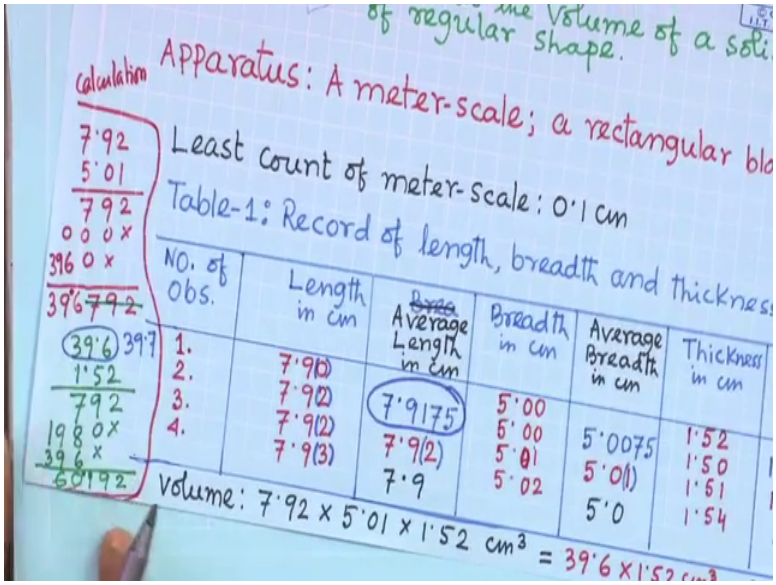
Now, you have to find out the volume ok. So, now, you have to multiply this length breadth and thickness. So, here is 7.92 right here 7.92; 7.92 and here 5.01; so 5.01 if you multiply. So, you are getting thirty nine point 39.6 792 6792. So, again you have to think

that whether I should write this one I should write this one, after multiplying this one, these two and then I will multiply the with the third one.

So, here again you have to follow some rules I will tell you that you can keep up to three figures from the left you can keep up to three figures, because why three figures this whatever this two you have to multiply these two numbers. So, what is with this is you have to see the smaller figures of these two numbers. So, this basically smaller figures how many figures are there? How many digits are there? 1 2 3 ok. So, if one of them is having the two digits. So, this is a smaller figures will be 2. So, here after multiplication you can keep up to this 2 digit. So, here since it is 3, you can keep 3. So, I have kept 39.6.

Now, 6 is followed by 7. So, it should be in principle 39.7. So, by here is I have taken 39.6, but you should be 39.7. So now, I will multiply with this 1.52 right 5 multiply with this 1.52 this thickness ok.

(Refer Slide Time: 40:19)



If you multiply with this 1.52 with three 39.7 in principle, but I have multiplied with 6 by mistake it should be 0.7.

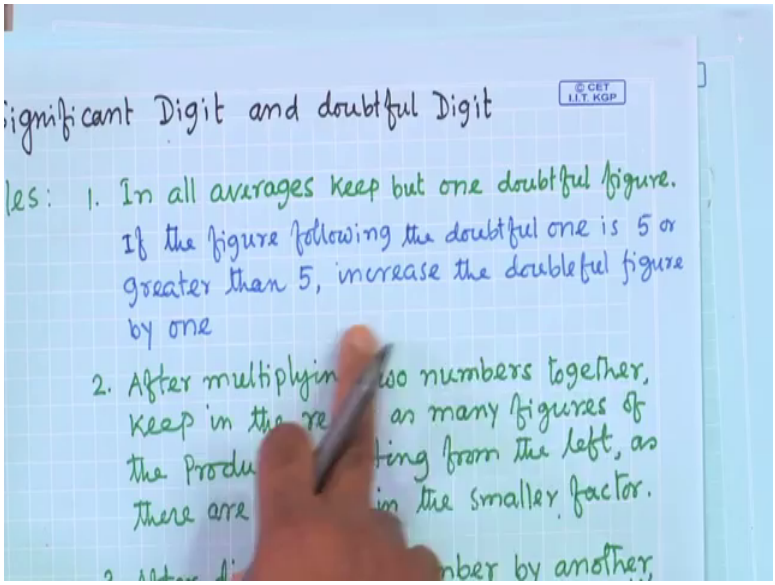
So, if we multiplied then it is coming again 60 point 60.192 the result is coming 60.192. here again these two digit you have multiplied. So, here minimum smaller figures are this basically smaller figures means how many digits are there? So, basically three digits

again three digits 1 2 3 ok; so here from the left you have to keep up to three digit 1 2 this 3 digit. So, 60 0.1, this reading will be 60.1 1 is followed by 9 ok.

So, this is the 60.2. And again since you have taken this large digit is doubtful digit doubtful digit. So, in results also whatever 3 you are keeping. So, last one is the doubtful digit. So, your result is basically 60.2 60.1 and followed by 9. So, it is increased by 2. So, 60.2 cm cube ok. So, here these two is again its doubtful digit ok. So, you have to keep in there actually accurate this you can demand the 60 cm cube now 60.2 you can demand, but you have to tell this last digit is doubtful digit ok.

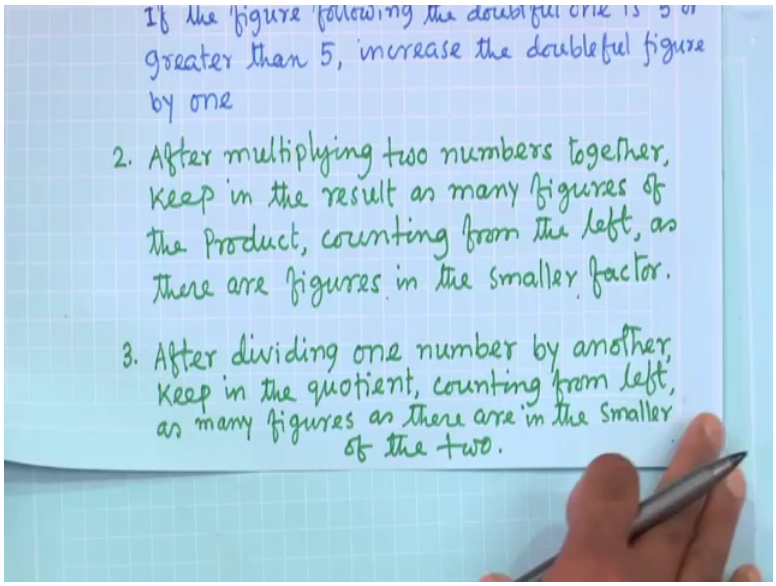
So, basically through this example we are learning what is the significant digit; what is the doubtful digit and how to find out.

(Refer Slide Time: 42:20)



So, rules are just I will tell you the rules are the significant is a doubtful digit rules is in all averages keep, but one doubtful figure you can keep one doubtful figure. See if the figure following the doubtful one is 5 or greater than 5 increase the doubtful figure by 1.

(Refer Slide Time: 42:41)



Then second rule is after multiplying two numbers together, keep in the result as many figures of the product counting from the left as there are figures in the smaller factor the two numbers you have multiplied. So, this there are factors right. So, what is the smaller factor? So, the smaller factor what are the figures that we have to find out. And then after that, after dividing one number by another, keep in the quotient counting from left as many figure as there are in the smaller of the two ok.

So, whatever I told you so this is the rule. So, following this rule one can write the significant digit and doubtful digit. So I think, I will stop here we will continue discussion next class.

Thank you very much.