Experimental Physics I
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Lecture - 45
Theorey and Demonstartion Platinum Resistance thermometer

So, today I will Demonstrate Platinum Resistance Thermometer, you know different kind of thermometer, one basic thermometer we commonly use that is a mercury thermometer right. Then, already I have demonstrated another thermometer that is thermocouple thermometer. So, today I will demonstrate platinum resistance thermometer. Means, the resistance of platinum wire changes with temperature. Now, with temper this resistance of the platinum is very sensitive to the temperature.

So, if we can measure the change of resistance with temperature. And, then one should calibrate this resistance of the platinum and the temperature then, this platinum resistance can be used to measure the temperature of any unknown temperature just taking the reading of the resistance of the platinum wire. So, basically this is the basic principle of this platinum thermometer, but we need proper arrangement for this.

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So, , this is the experimental setup for platinum resistance. So, first we should try to find out where is that platinum wire and that platinum wire we have see the change of

resistance of that wire with temperature; so that arrangement basically this is the arrangement.

So, what are the arrangement I need? I need basically platinum resistance platinum wire ok. And, then that wire the temperature of that wire I have to change for that I need arrangement. So, basically here this the in this tube this platinum wires are there. So, is difficult to see it, but I have another piece of this tube. So, I can show you. So, this the old one I can just open it and I will show you what are the things is inside.

So, this basically I can. So, here we see only mica foil only mica foil this wire you are seeing this rounded wire you are seeing. So, this wire is basically this platinum wire it is the platinum wire ok. So, I think few turns are there few turns are there and it is only mica sheet mica is basically insulator. So, and also we have to make sure that this wire should not touch each other in the in the middle ok. So, that is that arrangement is done. So, just we have you see we have made sure that this wire will not touch each other.

So, these two end of this platinum wire two end of this platinum wire is connected here with this screw and this another is here ok. So, this now this mica foil is attached with this strip with this strip. So, this one also we have used this screw and nut to attach this mica with this strip ok. Now, this 2 rod this 2 rod is basically electrically connected with this two end of this two end of this platinum wire.

So, now, you see these 2 these 2 rod is now it has taken out through this connection. So, here it is written you see is written is P is written is P you can see or not yeah, it is a P 2 written it is P 2 I can see it P 2 and this one is P 1 is P 1; that means, this platinum. Platinum this these towards are the 2 end of this platinum wire it is a electrically connected through this through this rod ok.

Now, another similar to rod are there you know here, another 2 similar 2 rods are also there. So, so, what is the reason for this 2 rod this 2 rod is called the compensating rod, because when will heat this platinum wire. So, this only this portion will not be in the e region where the where we want to measure the temperature. So, it may happen that this part also will be heated. So, any metal it is not only platinum any metal when it s temperature changes it is resistance will change.

So, so, here resistance is basically this platinum resistance as well as the resistance of these 2 rod. So, that whatever from here from here, whatever this resistance we will measure so, this resistance will not be the only resistance of this platinum wire, it will be the resistance of this 2 rod also ok. So, 2 another rod similar rod is put here; so this is we as I told this is a compensating rod.

So, for putting this 2 rod is reason is that the way, the way we will measure it is using Carey foster bridge that I will explain. So, there basically we want to we want to subtract this effect this effect of this additional this 2 rod ok. So, that is why this similar 2 rods we have put here.

So, here we want to compensate it because or subtract it because this resistance is not constant this will also change with temperature, that is why if this compensating rod is put here. So, resistance of this compensating rod also will change with temperature. So, this 2 rod connected with the platinum, resistance, or platinum wire. So, the way it will change this resistance of these 2 rod with temperature so, this compensating rod also will change in the same way. So, thus one can nullify the effect of this rod in the resistance of the platinum ok, by using this compensating rod ok.

So, this compensate rod is connected at this at this 2 point. So, here it is written see I think something S written anyway something is written looks to me oh c 1 and c 2 c 1 compensating wire 1 and compensating wire 2 or rod 2. So, these 2 are basically for compensating rod and the other 2 is for platinum wire including this of course, this rod.

So, in our this we are telling this thermometer this we are telling platinum resistance thermometer main part of this of this experiment. So, this is the platinum resistance thermometer. So, inside of this water so, this part is there I think this up to this up to this level so; that means, this not only this platinum wire this other part of this rod also it is in the in the water; so, if we boil this water.

So, temperature of this of this platinum, resistance, as well as the some part of this of this of this metal rod and this other part also will there will be gradient of temperature, but temperature will change ok. So, now here as I told this 2 are of platinum connection for platinum wire and 2 are connected for I think these 2 are for this compensating rod ok. So, what is the how we will?

So, how we will use this 2 2 2 P 1 P 2 and c 1 c 2? That will come in later part. So, now, so, this is the arrangement for the platinum thermometer resistance, platinum resistance thermometer. Now, what we want to do our experiment is basically we will heat we will heat this thermometer and temperature will change now with change of temperature, how resistances are changing that is what we want to find out ok. So, I have to measure the resistance of this platinum wire at different temperature. So, that is task ok. So, for that basically we are using this Carey foster bridge, we are using this Carey foster bridge.

You know Metre Bridge, you know wheat stone bridge ok, for is can be for wheat stone bridge. So, basically wheat stone bridge is basically there are 4 resistance PQRS you know 4 resistance PQRS ok.

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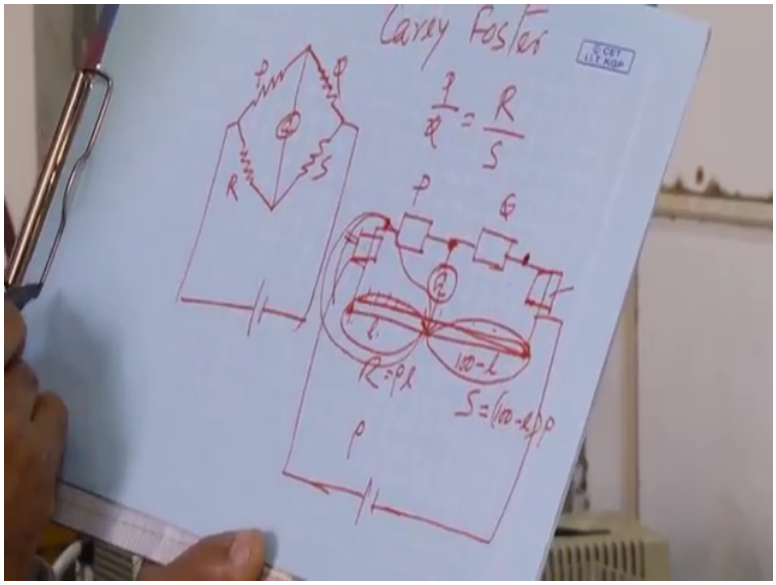

So, this is the wheat stone bridge ok. Say, this is P this is Q this is R this is S. So, between these 2 here this we put this battery and here we put the galvanometer right galvanometer. So, this bridge will be balanced bridge when there is no current will flow through this galvanometer ok. So, in this balance condition this P by Q equal to R by S right R by S. So, this Carey Foster bridge Metre Bridge. So, basically here you see you need basically 4 Resistance ok.

In metre bridge you know there is a wire of 1 metre, then you have 2 gap, you have 2 gap ok, you have 2 gap. So, in this 2 gap you can put your resistance P and Q, you can connect the resistance P and Q and from this point you have basically so, with some

galvanometer here there is a jockey you can shift it ok. So, this part so, now, this metre bridge 1 metre long this wire is there so, it has resistance and now if this is the balanced condition. So, this will be one resistance and this other part will be another resistance. So, this will be basically you can take R and this S right.

So, this R of this wire part if you consider the rho is the resistance of the wire per unit length. Now, there is a metre scale here, there is a metre scale here, there is a metre scale here ok. So, when you will get this balance point. So, we can get the length of this wire up to this. So, this say l 1 l this. So, rest of the part will be you know this is 1 metre mean 100 centimetre so, 100 minus l right.

So, now, R will be basically rho l and S will be basically 100 minus l rho right. So, here of course, you have to you have to connect battery. So, this P this is PQ in between this a and this is R A. So, we have to we have to basically connect battery here ok, correct battery here.

So, it is the basically metre bridge, but it will follow the wheat stone bridge principle right. So, similarly and the bridge is called the Carey Foster Bridge Carey Foster Bridge Carey foster bridge ok. So, there in Carey foster bridge basically, you have 2 more additional you have 2 more additional gap, you have 2 more additional gap, you have 2 more additional gap.

So, I think this gap the connection will take in such a way this gap will be I think will take connection from here and connection from here. So, this part will be added with this with this part of this wire of the metre scale wire of the metre bridge ok. So, when 2 additional gap will be there then the same bridge metre bridge, then we are telling this is the Carey Foster Bridge.

So, there is a purpose for this additional this 2 gap. So, this gap now this is P this is Q and this if you put some additional resistance here and here. So, this part plus this wire part this will be R and this will be S right. So, this is the Carey Foster Bridge. So, now, I will show this bridge this is a bridge you see this wire this wire is a 1 metre long it is the 100 exactly 100 centimetre.

So, so, is the 100 centimetre started from 0 to 100 right 1 metre long this wire is 1 metre long. And, it has 2 gap here this is say P and this is Q ok. So, additional 2 gap as I told

this one and is this one right now, we have just shortened it we have shortened it ok. So, it is a just like metre bridge it has only 2 gap. Now, think it is of it is metre bridge not Carey Foster Bridge, because now it has only 2 gap.

So, now, what I will do I want to measure the resistance of the platinum wire right. So, what I can do? So, this P and Q so, that I have to put somewhere at R at R or at S whatever.

Now, in I do not if this is not there I do not have option to put that one ok, with this one this wire additionally I have to put this resistance. So, I do not have place to put it. So, that is why this I need this gap. And, here say I will add this platinum wire connection. And, as I told this I have to mould this compen sating rod; so this compensating rod that part I will put here ok.

So, in balance condition so, P by Q equal to R by S somewhere I will get the balance point R by S. So, there this platinum resistance plus this rod resistance attached with the platinum wire; so this will come here. So, in S this resistance of this compensating wire rod that will be there. So, this resistance of this compensating rod and resistance of the resistance of this of the platinum wire addition of this rod.

So, that will be nullified balanced. So, all on the effectively I will get change of the length in the balance point equilibrium point. So, that because of this basically this the only resistance of the platinum wire; so, that is why this Carey Foster Bridge is required for this experiment.

So, now, you know this P by Q equal to R by S that condition I have to get. So, I need one galvanometer. So, this is P Q. So, from here as I told P Q here this we have to connect this galvanometer. So, we have connected this galvanometer we have connected this galvanometer ok; so this part is connected here and this other one.

So, this I will take as a jockey. So, basically if I just try to find out the equilibrium position, when there will not be any current in this galvanometer. So, I will find some position ok. Now, I have to find out the what is the length is a 64 say so, now, the P by Q equal to R by S. So, what is the P? Whatever resistance I will put here whatever the resistance I will put here that is a right now it is 5.2, right now it is 5.2 and it is also right

now it is also 5.2 same resistance. So, P by Q equal to 5.2 by 5.2 right equal to 1; so these are equal.

Now, you see here just these 2 part is shortened right. Now, this resistance of this left side wire and that will be R and resistance of the right side of this wire this it will be S ok. So, length I know then rho if I know the rho resistance per unit length of this wire then this one into rho that is R and 100 minus l into rho that will be S.

So, basically I should get in this condition when P equal to Q and this 2 are shortened, I should get this equilibrium position at the middle point say at 50, but shall we do not get 50, it is slightly less than or greater than 50 right so, because there is a contact resistance. So, this wire is connected here; so there is a contact resistance there is a contact resistance.

So, contact resistance at this end. So, if we consider this resistance is x and contact resistance is the other end if you consider that resistance is y. So, if x is not equal to y, then you will not get this balance point equilibrium point in middle. So, that first task is to find out this one ok, find out the contact resistance x and y right. So, how find out this one how to find out this one.

So, basically what we will do. So, here first experiment we have to do that here we will take the P and Q we will not take same we will take different resistance. So, say here it is 5 and here it is 2, then will find out the equilibrium position. So, l and 100 minus l 1 so, P by Q equal to R by S.

So, this in that in that equation I know P I know Q I know l right. And, there I have to add basically this R will be x plus l into rho and S will be 100 minus l into rho plus y this resistance right. So, l is a known to you and rho I think rho will go out right rho I just let me let me tell you here.

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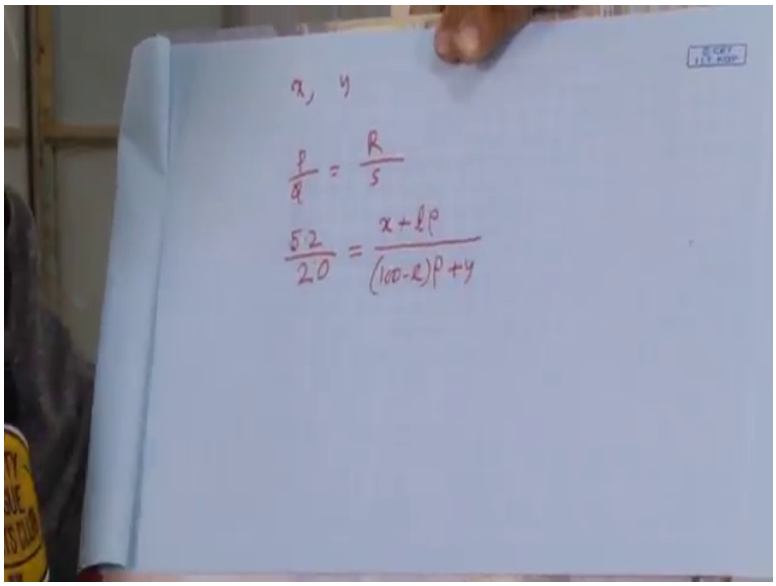

So, first we are trying to find out the contact resistance R 1 sorry x and y contact resistance right. So, P by Q equal to R by S P as I told we will take 2 difference resistance. So, 5.2 and another we will take depend 2.0 say yeah I think we have one resistance 2 ohm.

So, this will be equal to then if I get the balance point as at l. So, if I come from this side. So, 0 of this scale 0 I have taken here because this end is connected with the positive terminal of the battery. So, that is why that is why value it is we take the 0, where we connect the positive end of the battery ok.

So, that is why we are taking 0 here then that is other side it is 100 centimetre ok. So, if I get balance point at length l. So, this x so, in this in the R will be x plus l rho and y will be 100 minus l 100 minus l into rho plus y right.

Student: Only rho.

No so, yeah that also one can take or the just then it will be just resistance ok. So, this so, actually you can tell this x in terms of length and then it will be whole row or if you take this is ohm x ohm y ohm. So, then just you can write this way ok; so but here problem is.