Welcome to the physics lecture and today we will discuss the unit and measurement which we will cover. We will start with the description of the units and we will talk about the basic and the derived unit and then we will look at some different systems of units. And in particular we will look at the set of units which we follow is called the si unit and then the rest of the time we will study the measurement of length mass and time and also look at the range of measurements for these quantities. Is based on and measurements are very basic any quantity that we have to study we have to measure that quantity and qualitatively we can think of measurement let's say some simple question ? What is the time interval between sunrise and sunset? What is the temperature? When the milk starts to boil? What is the temperature of the milk? To answer the question we start learning how to measure physical quantity so our starting point is that we start by learning how to measure physical quantities .

Now the quantities we need to measure include length. It can be a forceful mass like mass time temperature and

so these quantities we want to measure how fast an object is moving

so we will talk about speed. All we do is we set a standard and set a physical quantity and that value Assign a unit for example we take a certain length and we say this length is one meter

so this means now it will be a standard length which we call one meter any other The thing to measure is that we express it as a factor of this length and when we say more than one this factor can be greater than this length means 3 times the length or 3 times the length or it can be a fraction of half this length and So this is how units are used

so what do we do after we set a value

so let's write this for example we set a certain length and we say it is now one meter now any other length is expressed as a multiple of this length

so something like that Twice the standard length we say is two meters and

so once we express a standard length then all the lengths are expressed in terms of it and the length can be as small as the radius of a hydrogen atom which is much less than the standard meter or the distance from it .

The distance from the moon to the earth or from the sun to the earth may be large which would be many thousands of meters but then what we have done is the standard length that we define it. The standard length that we have defined as the standard length of a meter is what we call a unit length

so this is how we define values now let's say we have a certain physical quantity q and when we talk about length it means something like that The length that we have defined

so we talk about a physical quantity q. We can write it as n times u where n is the dimension of quantity and u is the unit which you can now understand and just

so the same quantity can be expressed in different units. Say one foot to measure and it is allowed

so one can do

so the same amount can be expressed in different sets of units

so let us say that the quantity q we write this is the unit 1 which I call u 1 the quantity q is measured and it is measured Is done in the form of n one

so we write it as n one u one now we say in the same q unit u to u the n2 unit of u2 since q is the same this obviously leads us to n one u one equal n two u two and

so sometimes we Convert from one unit to another Conversions Converts using this formula are now in large quantities that exist in nature but we only need a few distinct quantities to measure them. Can be written in terms of

independent quantities
so we have a lot of physical quantity and let's say let's say we have the length of something we have the area we have the volume we have the acceleration mass force of time
so the number of physical quantities we want is quite large But it turns out that we only need a few quantities that are independent and other quantities can be expressed in terms of these independent quantities
so it gives us the idea that the quantities we choose as independent quantities are what we call. The basic unit is therefore the independent sums are referred to as the basic units and the other sums we get as the unit and the derivative .

So there is no need to take area as a separate quantity of quantity based on the basic quantity of length. Similarly, when I look at the speed of motion, length per unit of time covers distance per unit of time
so it would be a given quantity if length and time are my basic quantity. So we select some prime quantities and the other sums that can be expressed as prime quantities are called quantities. Mention the unit system
so whatever is in our unit system will start with some basic quantity or basic quantity and Then there will be other quotes antithesis which will basically be a product or a division of different amounts of energy
so how it works now, let us now look at different units of measurement at different times and in different regions which means different units have been used in earlier times or in different parts of the world since we We have seen that any quantity can be measured in terms of different units. Now till 1970 there were basically three systems which were prevalent in the first system
so till 1970s we had three main systems the first one we refer to as CGS system. In this CGA system of units the gram was used for mass per unit length and seconds was used for time
so units were measured in centimeters grams and seconds then there was another unit which was very popular and was referred to as unit fps system and In the fps system the foot length was used for pounds for mass and again the unit of time was used for the same seconds r time fps system is sometimes referred to as the British system of units and the third system of units which we used to refer to as mks system and here in mks system The meter used for length is used for mass in kilograms and has been used again for a second time since the 1970s which has been standardized in most parts of the world. The system is what we refer to as si unit or system international unit This is the world's scientific technology commercial work we usually use si units and one of the basic advantages of si units is that these units are based on decimal system
so they are based on decimal system conversions work like ten factor
so it is easy to use si unit now The si unit has seven base units which are used in addition to length mass and time. Other base units and let us list them one by one
so that the seven units used in si system first look at the amount of length using meters in si system and commonly used in si. The basic unit for mass is denoted by n The system is kilogram
so and its symbol is the basic unit used for the kilogram period is second and if we use the s symbol for this then we have the fourth quantity for which we provide the basic set of units is the electric current And the value for this is the single si system has amperes and we use the symbol a for this. Now here of course in si system we have ah amperes Use as a basic unit Now someone else could use charge as a basic unit instead of current and then they have a quantity called coulomb which could be used but when we define a set of units

the basic set for that system remains constant and in si system we We use amperes as one of the basic sets of units. So now the fifth unit is ah for which we measure the unit which we measure the unit. The symbol in the unit and the symbol used for it is ml and the final is the seventh set of prime numbers for which we write in our si system is the luminous intensity which is burning some bright things and the unit used in si units is candela which symbolizes cd
so these are the seven basic units Set is now a thing that one has to do. Once we define a standard unit for each of these, its definition is something like that. Which must be very precise and for example when we look at the meter it was originally a standard bar length which was kept at certain temperature conditions in Ah Lab in Paris
so that its length was defined as 1 meter but now the meter is defined in terms of the length of the path traveled by light. Done. How much light will travel in a given fraction of a given time in a given period of time
so that the length is given by meters and
so if you look at standard textbooks you will see how these are defined and there are some numbers that you can see many times the frequency of vibration And all these numbers when you look at any standard book you will be able to get a definition of how these standard lengths are now defined
so ah we see for example kilogram in kilogram is the mass of a standard prototype housed in the International Bureau of Weights in Paris and Now every country has its own standard lab. In India we have the National Physical Laboratory in Delhi which has a special block specially placed and
so we say its mass is one kilogram and it is equivalent to one kilogram mass which is kept in Paris. The time that we now have works is seconds Law is basically a given period of radiation consistent with certain atoms where things go
so they are very precise. All these standard units now have two more units which we define as having no dimension
so there are two dimensional units that have been defined and these are the units of some angles. So first we define when we have a planar case which means everything is in a single plane and here we and when we want to measure angles we define a unit called radians and the way we define a radian is that we take a circular pressure
so that our A circle has a center and we see a circular pressure , the distance or length of this pressure is s and if the angle called by the radial length of two rays is theta then we look at a sector of a circle whose length is equal to the radius of the circle and given the angle between these two As theta
so mbn angle theta is equal to s over r and we call this angle theta in radians so with radius The ratio of the length of the pressure to our specific units gives the angle of a certain quadrilateral which we call radius is now not equal to the degree of radiance which you know because what if we see a total circle now we know in terms of degrees if I move and I return to the same point Then the total number of degrees is 360. And degrees we use a superscript with the o sign to denote degrees
so it's a total number of degrees in degrees 360 degrees but in terms of radians if we see that when I move from one the total pressure length shifts to circle 2 pi r and if i by r Divide means I get 2 pi radians in terms of radians
so what we have is that if we look at it then 2 pi radians is equal to 360 degrees
so if we have degrees we want to see one degree is equal to two pi is equal to

sixty radians or pi Divided by one eighty radians then we will have ah the last points of this area
so the center of the sphere will be the radius of the sphere of all these. The solid angle that we have, if we call it d omega, if I divide da by r square it will give me the value of solid angle d omega or a measure and this measure we The unit called sterdian is therefore defined as the area of a spherical surface divided by the square of the radius of a solid angle. This can be done which is not like the basic unit but can be multiplied by In terms of 1 r is equal to 60 minutes and this is equal to 3600 seconds
so depending on how big our duration is we can use things like this
so we have different units for angles radians which we call si units but in terms of degrees and angles we This angle is 360 degrees when we say we go around a circle, but sometimes the angles can be very small and even the degrees are smaller. The tee is divided and the degrees of weight are broken down which is exactly what we do for the time being
so when we pause when we want to subdivide the degree for the angle we want to subdivide it
so we have the smallest unit for the degree is length For minutes, for example, when we talk about the lengths of large distances, especially for the astronomical range we use a unit of length is called a light year which is the distance traveled by light in a year and for this the light has to travel through space. When we find out the units, the units obtained will be a combination of different basic units of the system. Now the thing is that we also use some prefixes when we have very large or small measurements and these prefixes are used to order the same amount of dimensions. Let's use a word. If we have a quantity that is a thousand times the basic quantity, then the prefix used is kilo, and we all know that one kilogram is a thousand grams. The standard symbol we use when we have a factor of thousands is kilos. If the factor we multiply by is greater than ten to the power of six, then the symbol we used is mega. If we have another factor of thousands, we mean Multiply the power of 9 by 10 then we use one. The symptom is called gigabyte and if it has a power of 10 to 12 then giga is a thousand times more then the symptom we use is called terra Will be for the power of 12. So these symptoms are standard and the big one when we go to the power of 10 to 15 is called beating. There may be more but these are commonly used symptoms when we have magnifying things just like we can sometimes divide things into smaller units. And then we have a set of other prefixes
so for example when we multiply something by 10 minus 2 to the power which means we are dividing 100 by a factor of 10 to the power of 2 which is 100 then the prefix we use is 70 and the length direction Since we are very familiar with it we know one centimeter ah if we make it one hundredth of a meter or one hundred centimeters one meter
so commonly used prefi xes when we have a factor of one hundred percent we have a prefix centimeter similarly when we have a factor of one thousand When we divide, we have a prefix called milli and this is also known as millimeters and milligrams. If we divide it further, make it smaller. The power of minus 9 from a micro prefix of 10 is called nano. Nano is a very common term that we talk about in nanophysics today in physics which means we are talking about particles or particles. A commonly used small scale or small symptom 10 to minus 12 is the power of Pico
so these are sub-standards that you know the symptoms are used and you may encounter various problems
so you should get acquainted with them now. We move on to the measurement of length as we have seen the direct measurement of length is done by a meter

scale and the most common example where you see measuring length directly by the meter scale is that when you go to buy a garment the person selling the garment takes a meter And place the cloth opposite the meter scale and then if you want two meters. The fabric will then be doubled around the meter and this is how you get it
so now the meter scale will usually be used for a range of about 100 meters from the power of 10 minus 3 meters which is what you will do. Use a meter scale for the meter scale If you understand that they are small graduates it is first subdivided into 10 which is every 10 centimeters then it is divided into 100 parts which is 1 centimeter and the centimeter is further divided into 10 parts so each of these sections corresponds to millimeters but then if we add more Want to measure short length but we have a device called Vernier caliper which will measure power from 10 to minus 4 meters and we have micrometer screw gauge. ge or it is also called screw gauge which will measure the length from ten to minus five meters of force. Now it was a short length. A meter scale type method would not be possible if we could not use the meter scale or we had to measure things at distances and what we use there is called parallax method when the same point is measured by two different observation points and the position of the point seems to change And a very common example of this is you draw a pencil or something and you first observe the pencil with your left eye closed and then you observe the same object. Has happened and in order for this displacement to happen you need to see it in the background of something else that is fixed .
Although this thing is static but we can see it from different eyes. The object appears to be displaced from one eye or two different sets from the other eye. This point is called parallax and see the distance here The distance between two observation points is known to us and this is used to find the distance from the observation point. Observation point So the distance between two observation points which is known to us is referred to as base. It is called base
so we usually use b symbol for base and hence the distance between two sets of observation observations as we have said functional point is called base. We observe a point s
so we observe the point from an observation point a and we observe s from a point b point
so we observe s from a and b
so a and b our two observation points are objects
so far away Now when we do this the distance from a to s and b to s
so think of a and b as two. Observation points. So let's say the distance between two a to s or s two b is given by d and this is what we want to measure now the distance between a and b which is actually the basis we know and we say this is equal to b then what is done is we We measure the angle between the two sides with which s meets
so we measure the angle with the two sides that meet s
so we measure this angle and now if b by d is much less than one then distance by b is very large The angle is much less than one, the angle will be smaller than the angle and if so, then ab means this angle is smaller than ab.
Where distance is now measured in angle theta radians
so the distance d will be given b divided by theta
so we know the distance between the two observation points and we know this angle
so the distance of the position of s from the observation point can be measured now there is another quantity which We sometimes measure. Suppose we want to measure the size or diameter of a planet

so we have a planet whose diameter is d and we want to measure this diameter of a planet from a point on the earth. The planets will be placed on opposite ends
so we observe two points which are diagonally opposite to the planet. Now the angle subtanded by two opposite points let this angle be alpha .
Which is now the length of the pressure will be small d equal to the alpha time capital d and
so we will be able to get either small d or if we need angle alpha it will be equal to d on the capital d
so here you have to remember that alpha is the angle between the two sides When you look at the opposite points of the planet and in the case of such measurements when we make such measurements the angle we measure will be the degree we have degrees as we have said. And we know that one degree 180 is equal to pi by radians and it turns out if we work in terms of the energy of the decimal point 1.745 minus 10 radians and then if we do degrees we subdivide the angle further for another 1 degree sixty minutes. Equals we use zero for minutes we use a single cable curved line as symbol
so we have one minute or one minute it is equal to one by sixty degrees and it will become radians at 1.745 minus 10 divided by 2 divided by 60 radians
so We need to know how to convert minutes to radians and if we want to divide the minutes further, we have a unit for angles called one second and one second is equal to one by sixty minutes and seconds we write to place two of these curved lines. So we have one second, and this one second will be given as one point seven four five divided by ten into the power of minus 2 divided by 60 by 60 radians. Let's take an example of a problem involving this thing, let's say we've taken the problem, the moon is visible, be careful now and the best way to solve this problem when you solve such problems is to draw a picture and then work now. The moon is observed from two opposite points of the earth and so we observe the moon from two opposite points on the opposite end of the diameter of the earth and what we get is given to us the angle subtended b y two lines of observation given this angle as 1 degree 54 minutes And what we've been given is the diameter of the earth is equal to 1.76 tens of seven meters and all you have to find is the distance between the earth and the moon

so what we're going to do here is we can see if we can see if the earth is here There is an observatory b here and it is now given the position of the moon which is given to us from two different observation points we observe the moon and what is given is this co. The point is one degree 54 minutes and we need to find the distance between the earth and the moon
so the capital d unknown is the angle given here is 1.54 meters and the distance ab is given to us one point two seven six to ten energy seven meters
so what you need to know to solve this problem All that is required is that the length of a circle is equal to the radius multiplied by the ab
so d is equal to the diameter of the earth d at an angle where the theta is one degree fifty four minutes Do and then your distance will be ab 1.276 to the power of 10 7 meters it will be the distance d m multiplied by 1 now the angle theta now if we look at 1 degree 54 minutes it will be equal to 60 plus 54 minutes it will be equal to 114 minutes to us There is a factor
so this will be in 114 minutes and we have already seen that one minute is equal to 1.745 by 10 minus two divided by sixty radians
so it is one point seven four five two by ten divided by two O sixty and now we've done this
so we get the power d equal to 1.276 of 10 to 7 divided by 7 to 60 114 by one point seven four five by ten minus two meters of energy

so that we can do it ah we move on In the next class of w we will start with a range of length scales and then we will look at some ways to measure short length scales and we will show you how to use two devices vernier caliper and a screw gauge. Thank you.