hello in the last class we discussed the discovery of electron and nucleus we saw different models of atoms we discussed about the dalton's atomic model then we discussed thomson's plum pudding model and we also learnt about the rather force atomic model in today's class we'll begin with by discussing what is this nucleus made up of we'll first learn about the stories of the discovery of those internal structure of of the nucleus this is what we are going to do next that was answered by the german physicist organ goldstein uh from his series of anode ray experiments these experiments are very similar to the cathode ray tube experiments with ah two important ah changes one first of all he took a ah glass tube as it was in the cathode ray tube one important change is that it was not completely evacuated rather a small pressure of of gas was maintained in in the in the glass tube ok and then of course this tubes have ah two electrodes they are fixed with two electrodes let us ah we and they were connected to the other difference that was done was if you remember in the cathode ray tube we had one hole in the center of the anode here what we do is that we create

so now the way we have applied the potential difference the polarity

so just that this is my cathode negatively charged electrode this is my anode what is done is that we have used a perforated cathode

so there are ah i am drawing ah three holes here and the anodes are ah this is my anode plate all right

so the second ah change is that we have used a perforated cathode and we are applying high voltage when we apply high voltage we know that cathode rays will start from cathode and they will travel to anode but when these cathode rays which are now the series uh we know that they consist of electrons the particles electrons when they come they hit on these gas molecules which are present in this gas glass chamber and when they hit these gas molecules they ionize this gas molecules which are present here by ionization what happens is that this gas molecules they lose some electrons and when they lose that electron that electron travels towards the anode and the cations after removal of the electron this this ah positively charged gas cations they get accelerated towards the cathode plate because they travel since they are positively charged they travel from anode to cathode

so we see some rays now from anode to cathode and these are positively charged since we have perforated ah cathode plate

so this rays they pass through the cathode and they again can hit the screen we can have the zinc sulphide coating here

so that we can see the bright light when the rays hit the screen now again you can redo the experiment that was done by jj thompson to show that here are these rays which travel in straight line from anodes to cathode they travel from anode to cathode and we call them therefore a node rays and you can show that they are positively charged and they they will you can also carry out several experiment and determine their e by m what was however observed here that this e by m the charge to mass ratio depends on the nature of gas depends on the nature of the gas

so if you use hydrogen you have a certain value of e by m if you use helium it has got certain ah some different values of e by m for this anode rays

so these are called anode rays here by doing several experiments it turned out that the smallest positive ion was coming from hydrogen that was the smallest the lightest ion that had the smallest mass that was coming from hydrogen atom right and in 1919 it was it was shown that this hydrogen ion is is called what we know as was proton these protons they are present in all the elements they are the center of the positive charges they have some certain the charge that was discovered for this proton was exactly the same charge that of electron but it is now positively charged instead of electron uh which was negatively charged

its mass was discovered which was to be ah which which was to found to be about 2000 times heavier than an electron

so from this anode ray experiments we realized that the nucleus contains protons which are the center of positive charge which are also the same the particles that provide mass to the nucleus ah but then there are ah there was another problem that will ah discuss now for example when it was ah observed that hydrogen atom let us consider hydrogen atom

so it was seen that according to rather force model we can draw that the nucleus contains one proton and of course there is an electron the electron is massless compared to the proton

so the mass of this atom is primarily coming because of the presence of one proton

so we have mass of hydrogen from from brother force model i mean we can get the mass from doing experiment then lets compare it with helium

so helium has got two electrons and it has also a nucleus and this nucleus has now got two protons right

so the number of protons in helium atom is double that of the number of protons in hydrogen atom this would indicate that since it is only the proton which gives ah rise to the mass of the atom it would uh suggest that the mass of helium atom must be twice the mass of hydrogen atom however the experiments showed that mass of helium atom is somewhere close to the close to four times of the mass of hydrogen atom that was surprising why should that happen how is helium getting more mass ah where where from is it getting more mass this is one question the other question is that if you look at the nucleus now the helium nucleus has two protons they both are positively charged particles

so why are they not repelling away from each other

so why is helium nucleus still stable they should simply go away from each other this could not be explained from rather force model uh it was in 1932 that james chatwick he says he did a series of experiment and discovered that nucleus of course contains nucleus contains ah protons as we have discussed we discussed earlier which has charged particles in addition to protons it also contains a new set of particles new particles that are called that he called as neutrons these neutrons are have charged less

so they have zero charge and it was found out their mass is equivalent to mass of a proton ah if it was after ah james chadwick's discovery of neutron it turned out that helium atom in addition to two protons it also has two ah neutrons and since the mass of neutron is equivalent to the mass of proton

so therefore in the nucleus of helium atom we have two protons two neutrons and in case of ah the hydrogen you have got only one proton and this explained why mass of helium is nearly four times that of mass of hydrogen

so we can summarize uh now the sub atomic particles that we discussed we saw electron it has a charge 1.6 into 10 to the power minus 19 coulomb which is negatively charged we discovered ah we came across proton which has exactly the same charge as electron but it is now positively charged and we have a third particle which is neutron which is charge less or this has zero charge in a relative charge scale we can just say that electron has minus one charge proton has plus one charge and neutron has no charge when you look at the mass of these particles we see electron has mass of nine point one into 10 to the power minus 31 kilogram proton has 1.6 into 10 to the minus 27 which is nearly about 2 000 times heavier the proton is heavier than electron and the mass of neutron is nearly equivalent to the mass of proton in amu scale atomic mass unit we can say that the proton has 1.007 amu mass neutron has 1.

008 amu we can roughly say that neutron has one a mu mass proton has one a mu mass and electron is massless almost ah nearly zero in this way we discovered we discussed about the discovery of electron proton neutron what how the nucleus is is made up of the individual charges and their mass of this fundamental particles ah let us summarize first before we start any further we discussed about electron i call it e minus ah then we also had proton i call it p plus and then we discuss about the neutron n these are the three fundamental particles that we discussed let us make this stable we have charge we have mass if you remember electron had relative charge of minus one proton heart is relative charge of plus one and neutron is a neutral particle

 so therefore there is no charge charge is zero when you looked at a mass which we knew that we got to know that proton and neutron they have one amu mass each roughly equal compared to the mass of neutron and proton the mass of electron is negligibly small therefore we took it as zero

 so this is the charge and mass scenario of our sub sub atomic particles using these three sub atomic particles we would try to identify will now spend some time in discussing or establishing the identity of an atom right identity is a very important issue if i want to find out about you what would i do i would first ask well i i want to know this student from this school but that is not a sufficient information to find find you out because your school will have

 so many students then i will say okay i need a student who is studying in this school and who is in class 11th for example but in your class 11th there are

 so many students

 so i have to tell that okay i need this student who studies in this school in class 11 and his role number is this and this that will be an exact identity of yours similarly to identify an atom or the to establish the identity of an atom we need some identity indices the most important is what is called as atomic number this is given as symbol z this is nothing but the number of protons in your atom in the atom all right but atomic number alone is not sufficient to establish the identity of an atom we need another quantity and that is called as mass number the mass number is given by ah the symbol capital a which actually signifies the mass of the atom from this table you already know that which of the particles contribute to the mass of the atom certainly not electron because electron has very little mass is negligible

 so proton and neutron they contribute to the mass of the atom

 so therefore in when establishing mass number we say ah number of protons plus number of neutrons but we already know the number of protons is is given by z

 so mass number is z plus the number of neutrons these two are very important quantities but in addition to them we also require another quantity and that is the charge on the atom let us call it by small q how do i determine the charge why do i have charge in the atom because i have got two different charge particles two different types of charged particles in the atom one electron which is negatively charged the other is proton which is positively charged neutron does not contribute anything towards charge

 so when i am trying to establish the charge of an atom i can safely ignore the neutron

 so the charge of an atom is given as number of protons minus number of electrons this minus is coming because electron has negative charge and proton has positive charge

 so this equation would actually fit let us take some examples let us say i have a i have an atom which has five protons

 so five p plus each proton has plus plus one charge

 so it has it the protons contribute plus five charge and let us say i have got five electrons each electron has minus one charge

so therefore net contribution of charge from the electron side is minus y and when i combine them plus five minus five i got the total charge as zero if i have if i had five protons and six electrons

so you know that this is five plus and this is six minus total charge is minus 1 similarly if i had 5 protons and only 4 electrons

so plus 5 minus 4 that gives me plus 1

so this way i can obtain atomic number mass number and charge these three quantities are sufficient to describe the identity of an atom we'll use these concepts in and take some examples to clarify our knowledge further all right our first example let us call example 1 let us say i had i will use this hash sign for number

so let us say i have a system where number of proton is six number of electrons is again six and number of neutrons is six ah what can we say about this atom all right we know that the atomic number of this atom that is z is given as six the mass number of this atom a which is number of proton plus number of neutrons

so 6 number of proton plus 6 number of neutrons that is 12 charge of the atom which is obtained by number of proton minus number of electrons

so in this case six minus six and that is zero

so we have got an atom whose atomic number is six mass number is twelve and charge is zero there is a shorthand notation way of writing all these information the shorthand notation is given in this way it is written as z a x

so z is the subscript of x a is written at the superscript of x both z and a are written to the left of x and on the right hand side right hand superscript of x you write the charge this is a shorthand notation of of of an atom let us see we know z we know a we know q but what we do not know is this x this x is nothing but the chemical symbol corresponding to the value of z for example let let us take this example here z is 6

so i can write 6 a is 12 i can write 12 in the place of a and then charge is 0 but i don't what should i write in the place of x this chemical symbol corresponding to z value of 6 if you check periodic table i hope you know it by her it comes out to be carbon

so we call this element as carbon whose atomic number is 6 whose mass number is 12 and which has no charge this is also equivalently written when the charge is 0 one does not need to specify the charge

so therefore you can equivalently equivalently write c 6 12 in this way by ignoring the charge and this is done when q is 0.

you can see that the 6 corresponds to carbon or carbon corresponds to the value of z z as 6.

so therefore these two are both writing both these information is perhaps unnecessary

so again equivalently you can write c 2 l just like this because by writing c you already signify that z or the atomic number is six

so you do not need to write

so this three equivalent way of ah writing a is is normally done let us look at another example ah in this case i have number of protons is 16 number of electrons is 15 number of neutrons let us say it is 18.

so what is my z z is number of proton that is 16 that's very good what is my mass number that is a which is number of protons plus number of neutrons

so 16 plus 18 which is 34 what is the charge i see here 16 positive uh protons 15 electrons

so 16 positive charges 15 negative charges that gives me 16 minus 15 which is plus 1 how would i write down in in the shorthand notation of course

so z is 16 a is 34 if it is if z it is z then it sorry z is 16 then the symbol is sulfur and the charge is one
so this is this is the atom that i found out will take ah two more examples and try to understand ah what more information can we can we get let us take another example let us say we have this information cu 2963
so this is copper atom whose atomic number is 29 whose mass number is 63 and we have to find out the number of electrons protons neutrons the charges on this
so of course sorry the charge is given as 0.

so what i know i know z is 29 a is 63 q is 0
so number of electrons i can sorry let us find out number of protons first number of protons is atomic number
so this is 29 since the charge is 0
so number of electrons must be equivalent to number of protons and number of neutrons is a minus z which is 63 minus 29 and that is 34.
we got that ah let us look at another example this time it is a calcium 2 plus atom mass number is 40 atomic number is 20.
this 2 plus a 1 plus or 2 minus this represents this atom is actually in an ionic state
so this is a cation in this case of course z is 20 which is the atomic number mass number is 40 and charge is plus 2 or 2 plus i dot all right
so let us find out how many protons are there it's easy because z represents the number of protons
so number of protons are 20 how many uh neutrons since mass number is 40
so 40 minus 20 is 20 there are 20 neutrons how many electrons you see the atom has plus two charges and plus charges are coming because of proton
so i have got 20 protons and the atom has got two positive charges that means number of electrons present in this atom must be two less than the number of protons
so if number of protons is 20
so number of electrons are 20 minus 2 which is 18.
all right we'll take a few more examples because this is this is very important concept let us now take three different atoms c 6 12 c 6 13 c 6 14.

so you see there are three different carbon atoms in each of them the z the atomic number is 6 the mass number varies from 12 to 13 plus 14.
all right let us ah establish number of protons of course 6 6 6 because this is z value number of electrons all three species are neutral
so number of proton is equivalent to number of electrons
so that is easy let us find out number of neutrons the mass number in this c6 12 is 12 that means there are six protons plus six neutrons in this case the mass number is 13 the atomic number is 6
so number of neutrons is 13 minus 6 is 7 in this case mass number is 14 atomic number is 6
so number of neutrons are 14 minus 6 which is equivalent to 8.
now what we see here is that there are three different elements they have similar same value of z they have different values of a and that is happening because they have different values of neutrons when two or more elements have same z and different a that means same atomic number different mass number we call them isotopes
so carbon 12 carbon 13 carbon 14 there are three different isotopes of carbon in nature sometimes you would see carbons 12 sometimes you would see carbon 13 sometimes you would see carbon 14.

so whenever we talk about isotopes they also come with their natural abundance for example c12 is the most abundant carbon form which comes about to be almost 99 percent c13 carbon 13 is roughly one percent and carbon 14 is is seen in the nature but in the it exists what we call as in trace quantities it's very very tiny amount and almost negligible but it does exist and it has very important ah properties

so we saw when ah two or more ah atoms have same atomic number but different mass numbers we call them isotopes we will take one more example of isotope and that is our example number six ah this is these are now the ah isotopes of hydrogen

so we have three different forms of hydrogens in each case z is atomic number is same that is one and the mass number changes ah from one two to three

so of course it is very easy number of protons is all one number of electrons since they are neutral

so all one number of new neutrons are in this case the mass number is one atomic number is one

so number of neutrons is zero there is no neutron ah in this case mass number is two atomic number is one

so number of neutrons is two minus one one and in this case number of neutrons are three minus one which is two

so we see that these three species they have different number of neutrons this hydrogen 1 is called as protium hydrogen 2 is called deuterium and hydrogen 3 is called tritium ah their natural abundance protium is 9.
99.
985 percent deuterium is present in very small quantity 0.
015 percent and you can see ah tritium ah is present in trace amount all right

so these three are again isotopes these are the isotopes of hydrogen ah let us take one more example in this time ah this example i am this is hydrogen 3 and i am going to compare it with helium 3 but helium's ma atomic number is two again let us write down number of protons

so number of protons in this case is one number of protons in this case is two because this is helium number of electrons both are neutral

so therefore number of electrons must been equal to number of protons in each case and number of neutrons in this case you would see how how many neutrons are there mass number is 3

so 3 minus one is is two in this case number of neutrons are three minus two is is one

so number of neutrons are two uh one in this case if you see these two species have same mass number same value of a but different z same mass number different atomic number same mass number different atomic numbers when you have such a case we call these two species as isobars

so hydrogen 3 and helium 3 they both have same mass number but they have different atomic number

so therefore they are called isobars we will take one more example and that will be our ah last example let us consider these three species sulphur 36 chlorine 37 calcium 40 let us find out number of protons in this case ah the sulphur number of protons are 16 chlorine number of protons are 17 calcium number of protons are 20 i know this from periodic table number of electrons since all three species are neutral

so number of electrons are equivalent to the number of protons otherwise they will be charged number of neutrons i am sorry number of neutrons in this case there are 16 protons 36 mass numbers

so number of neutrons is 36 minus 16 which is 20 in this case uh number of protons are 17 mass number is 37

so number of neutrons are 37 minus 17 20 in this case also ah number of neutrons is 40 minus mat number of proton is 20

so therefore 40 minus 20 is 20 we see these are three different species one is sulfur another is chlorine another the third one is calcium but what we see is that they are related to each other in terms of number of neutrons

so they have same number of number of neutrons when we have such a situation we call them isotones when the number of neutrons are equivalent in in two or more number of species

so in this way we learnt about how to use the number of electron number of protons number of neutron information to define an atom how we can discuss about isotopes isobars and isotones

so far we have seen ah the sub atomic particles in the in an atom and how we can use this information to define or to identify an atom now we will learns about something else ah which is very important in atomic structure ah in the understanding of atomic structure and that is light or we also call it radiation we will use this both the terms interchangeably all right you might wonder that we are supposed to learn about atomic structure why were you talking about light light pleasant plays a very important role in determining the structure of atoms and molecules the branch of science that we call spectroscopy has given us a huge amount of information about the structure and properties of atom simply by interacting light or radiation with matter

so we need to understand the properties of light uh the nature of interaction between light and matter to be able to understand the structure of matter structure of item structure of molecules properly

so we will spend some time in discussing about light light although we use it all the time but the nature of light has kept scientists busy for long long period of time during newton's time light was believed to be octet like particles the famous newton's corpuscular theory but afterwards

so for some time light was believed to be a particle then afterwards of several experiments showed that light has wave like properties because light showed diffraction light showed interference which are typical wave properties

so since light showed this diffraction and interference it was believed that light behaves like a wave light is a wave afterwards we would discuss during this course of our discussion afterwards there were

so many experiments which were coming out which could not be explained if we invoke the idea that light is a wave

so on the other hand when we used light as a particle we could again explain all those experiments all the observations that we experiments were showing us we could explain them

so now light is a particle sometimes light is a wave at the end of our discussion we will come out with this that light is both wave and a particle

so this is called duality of light

so light can be a wave light can be a particle depending on the experiment that we are trying to explain depending on the action that light is carrying out light adopts a particular ah particular form is either wave or part particle but it is always both wave and particle and it can choose whichever ah face of itself to show that it wants all right we'll first spend some time in discussing about the wave nature of light as i said ah light was believed to be wave because it showed diffraction and interference and these these properties are these features are typically seen in the wave

so there therefore light was believed to be web in fact for some time lipo light was believed to be a transverse wave because its property matched with many other transverse waves but afterwards after some some some time james maxwell suggested that well light is a wave but is a special kind of wave it is

not a not an ordinary transverse wave what he called is that light is an electromagnetic wave this is a special kind of wave as the name suggests that it has got an electric component in it it has got a magnetic component in it and it is a wave

 so its a special kind of wave that james maxwell proposed

 so as the name suggests that this electromagnetic wave or electromagnetic radiation has got an electrical component electrical field and magnetic field

 so this wave when it propagates it produces an electric field it produces a magnetic field ah there is some interesting aspect about this electric field and magnetic field that it produces the

 so this is in this picture you see that the light is being propagated along this direction when the light is propagated it produces an electric field which is given by this ah red line let us let us call it call this as electric field component and it also has got a magnetic field component which is given as in the blue line

 so so when light is propagated it produces an electric field and a magnetic field but what is interesting is that the electric field and the magnetic field that it produces they are orthogonal to each other

 so you can see ah in this picture you can see the the three cartesian axis here

 so call this as origin

 so this is one direction call this as z ah call this axis as x call this axis as y

 so in this diagram i am showing that electric field is appearing along x axis

 so you can see ah the propagation of electric field is along x the magnetic field appears along y axis in this plane and the propagation the wave which has now electric component and magnetic component the wave when is when it is propagated the direction of the propagation of this wave is perpendicular to both electric field component and magnetic field component

 so the wave is actually getting propagated along this direction called z direction if the light wave is getting propagated along one direction it produces an electric field which is perpendicular to the direction of propagation and it produces a magnetic field which is perpendicular to both its direction of propagation as well as the electric field component

 so this is a special nature of this electro magnetic wave or electromagnetic radiation all electromagnetic radiation ah show this this kind of behavior all right

 so this is one ah important property of electromagnetic radiation the other electromagnet property that we would study is that we would appreciate is that electromagnetic radiation or electromagnetic wave to be propagated it does not require a medium what does that mean it does not require a medium that means it can be propagated it can be it can move in vacuum this is unlike any other wave other waves require a medium to to be propagated to move but electromagnetic gradation they do not require any medium to move

 so therefore it can move ah it can move in vacuum in vacuum this is a very important ah property and third property is that all electromagnetic radiations all electromagnetic waves have same speed have same speed in vacuum and this speed is actually a constant and this constant you would know a speed of light is given by sorry i am sorry ah this constant is given as 3 into 10 to the power 8 meter per second this is the speed of light that that you know

 so the electromagnetic radiation which is light is an example of that ah this electromagnetic radiation has electric field component magnetic field component they are perpendicular to each other to prop to move it does not require a medium and all electromagnetic waves travel at the same speed that is in vacuum they travel at the same speed and the speed is 3 into 10 to the power 8 meter

per second which you know as the speed of light next we will discuss about some properties or some characteristic of of a wave because we are discussing light as a wave

so we will spend some time characteristics of a wave when you see wave i will show you one example of a wave here you see i am ah its a its a wave where you see this is the normal position

so you have created some disturbance that is why the the system is now getting displaced

so whenever it is going away from this normal position which is this horizontal line that is called a displacement we require some ah characteristics uh characteristic property to define a wave the first thing that we need is what is called an amplitude see if in this wave at every point you see some displacement at this point you see a displacement like this at this point you see another displacement another value of displacement like this and then in this direction the displacement is along other direction at one point of time you would see that the displacement is maximum and this value is called the distance between this from the normal position is called amplitude this distance is called amplitude if you compare two the place where maxim the amplitude is seen or maximum display displacement is seen we call them crest if you if you look at two consecutive grades trace the distance between them is called wavelength the other property that we need to understand is wavelength as the name suggests it is it is a form of length we call that we signify that as lambda the unit that we use it can be any length unit but in our discussion we will use ah the unit of nanometer or angstrom all right

so this is another property ah the characteristic property of a wavelength that we need to know to define a wave while if we know wavelength we have already a lot of information about the thing but then we will come across another term of one and that is called a frequency what is a frequency you see that the wave is actually propagating

so the wave will will move the frequency is that if you sit at any point at any point here let us say i am sitting here and the wave is getting propagated at a at a particular speed since it is i am discussing about an electromagnetic wave ah its speed is 3 into 10 to the power 8 meter per second

so it has a fixed speed that it is getting propagated through in vacuum alright

so i am sitting here and the wave is getting propagated i'll count in one second how many wavelengths are passing by

so i'll just move this uh wave here

so i am sitting here i'll my pen will stay here and i will move it

so i assume that i am moving it at the speed of light of course i cannot do that

so when i i will do it again i am here and i am moving the wave and then i see

so i would keep on i am still my pen is static and the wave is moving right i'll say that in one second how many wavelengths i am encountering

so you see that that is that number of wavelengths that i see at one position in one second is called frequency

so it is number a certain number of wavelengths per second

so that is known as frequency and since its it is given as the symbol new and the unit will be since it is a number per second

so it is second inverse or it is also called as hertz after the scientist heinrich hertz ok ok ah i see that ah this is this is my wave i i will show you another way look here what what is the difference that you see this wave has this wavelength and this wave has got another wavelength if you compare obviously this wavelength is greater than this wavelength i have tried to keep the amplitude of the two waves same only i am changing the wavelength here

lambda is less now what will happen to the frequency you see frequency to get the frequency i have to sit at one point wherever i can choose any point i am choosing here and i have to again move this wave get propagate and i see in one second how many wavelengths am i crossing

so since the lambda is small here the wavelength is small

so you can imagine that in one second in a given time i will cross more number of waves for this wave than this wave with larger wavelength right

so that means

so when my wave length is small i would see more and more number of waves passing by in one second

so when my wave length is small frequency is large when my wave length is large the frequency is small

so there is a there is an inverse relation between wavelength and frequency and this proportionality constant between this wavelength and frequency is actually given by the speed of light because both the waves are actual since they are electromagnetic waves both the waves are actually going at the speed of light

so we have this ah relation which is lambda into nu is given by c which is the speed of light which is a constant this is very important relation we require we sometimes come across another terminology and that we call as wave number it is nothing but reciproc we signify as nu bar this is nothing but reciprocal of lambda 1 over lambda the unit that we use to define it is nanometer inverse or angstrom in inverse essentially any ah length inverse unit but we will use nanometer or angstrom wave number is essentially the number of wavelengths that you can fit in per unit length this is essentially the reciprocal of wavelength we will take one small example let us say let us say we have a wave whose wavelength is 5000 angstrom find out what is the value of frequency find out the value of the wave number ok this is

so right let let us solve it lambda is 5000 angstrom you know one angstrom is 10 to the power minus 10 meter

so i have 5 into 10 to the power minus 7 meter this is i am converting the unit to s i

so lambda is now 5 into 10 to the power minus 7 meter and how do i get new because i know lambda multiplied by nu the frequency is c

so therefore nu is c divided by lambda you see nu is inversely proportional to lambda but the proportionality constant is is is the speed of light

so speed of light i know 3 into 10 to the power 8 meter second inverse lambda is 5 into 10 to the power minus 7 meter which will give me 0.
6 into 10 to the power 15 meter meter cancel out

so second inverse or i can write it 6 into 10 to the power 14 hertz right similarly this is this is the frequency corresponding to the wavelength of 5000 angstrom similarly i can also get nu bar which is nothing is which is easy one over lambda lambda is 5 into 10 to the power minus 7

so therefore this comes out to be 1 divided by 5 into 10 to the power minus 7 meter which is nothing but 0.
2 into 10 to the power 7 meter inverse right

so here we learned about the characteristics of as you can see the electromagnetic radiations come at they can they may come at very different values of lambda when the lambda changes the frequency would change keeping the value of c constant we will now see i will now compare different electromagnetic radiations with different values of wavelength frequencies this is called ah electromagnetic spectrum in this diagram you see what is called as electromagnetic spectrum in this axis you see ah it there are some numbers 10 to the power 24 to 10 to 12 10 to the power 6 10 to the power 0 which is essentially 1 and these numbers are expressed in the units of hertz which is

frequency and in the same in the same diagram the lower scale shows the numbers which are expressed in as as wavelength in the unit submeter it goes from 10 to the power minus 16 to 10 to the power 8.

it's quite a wide range of wavelengths quite a wide range of frequencies let us look at very high frequency that means the wavelengths are extremely small 10 to the power minus 16 meters these energies are called gamma rays they have extremely high energies as you go higher and higher in wavelength and therefore lower and lower in frequency you you will come across x rays which have 10 to the power minus 10 ah meter wavelength and these x-rays are used to ionize substances and also take x-rays of our body in last class we saw how x-rays were used in millikan's oil drop experiment to to ionize the gases inside as you go higher in in wavelength you come across this ultraviolet radiation you know you perhaps have heard about ultraviolet radiation which comes from the sun because of the depletion in ozone layer the uv radiation comes and when it interacts with our skin ah it can cause skin damage after ultraviolet comes the visible this is very important range because this range of well length is what we use to perceive things our our eyes can perceive these colors these 400 to 750 nanometer wavelengths i will come to come back to this visible spectrum in a moments time before that let us go across after uv you get visible visible starts from violet ends with red before violet it was ultraviolet after red it will be infrared there is infrared radiation as you go further it is microwave radiation the radiation that you would use in the microwave oven and further when you go you see at larger wavelengths you these are radio waves these are used for uh transmission of your radio programs you must have heard and finally at very long wavelengths you will see this these are called long radio waves and this will their wavelengths are 10 to the power 8 meter or or the frequency is simply 1 that means what what does it mean that if i sit at one point and will i'll check how many waves are passing by i would see in one second these waves are traveling at the speed of light 3 into 10 to the power 8 meter per second it's a quite high speed even then i would see only one wave passing by me every second

so that means these these frequencies have extremely large wavelengths now let us come back to this visible spectrum we have oppos v violet indigo blue green yellow orange red ah this is the visible spectrum that goes from 400 to 750 nanometer the red light has higher wave number the red lights are high of higher wavelength and blue lights have lower wavelength and uh that is why you see red light in the traffic signal

so that you can see the light from far the blue light have low wavelength but have high frequency and this blue or violet light is what you see flame in the gas stoves in this class we discussed about the wave nature of light in next class we'll discuss about the other properties of light thank you you