welcome students
so this is the first lecture
on sets first let me define what is a set
so a set is a well defined collection of objects a set is a well defined collection of
objects or sometimes we say elements
so let me explain what do i mean
by a well defined collection
so by well defined collection we mean that given an element given an object we can clearly determine whether the object is in the collection or not right
so let me explain it by example
so one the collection of all vowels of the english alphabet
so what is this collection
so we have the
english alphabet there are 26 alphabets a to z and we know that there are five vowels a e i o u
so this is a well defined
collection
so given an alphabet you can tell whether the given alphabet is
a vowel or not
so this is an example of set this is a set second example
so suppose i say that the collection of eleven best cricketers in the world
so this is not a well defined collection
because it depends on peoples perspective who is a better cricketer
so this will not be said this is not a set ok
so we will see many
examples of sets in due course
so for notations we shall usually denote sets by capital letters for example a b c x y etcetera and the elements we denote the elements by small letters like a b c x y z etcetera another notation
so we write a belongs to a this is read as a belongs to the set capital a or a is an element of the set a to say a is an element of the set capital a
so for example let a be the set of all even natural numbers right which means that a is the collection of all
natural numbers which are divisible by two
so then the natural number two this is an element of
the set a right we write two belongs to a but the natural number three this is an odd number not an even natural number
so two is three is not in the set a
so for not an element of a we cross this epsilon
so now we will see how to represent a set
so representation of sets
so there are two ways by which we generally represent
a set first one is called roster or tabular form
so in this roster form what we do is that
we list down all the elements of the set
so all elements of the set are listed within this curly braces and separated by commas
so for example they said a consisting of all even natural numbers less than or equal to 10 will be represented by a is equal to
so we just asked
what are the elements of this set a
so we want all the even natural numbers
which are less than or equal to ten

so the smallest such even natural number is
two then the next one is four six eight and ten sometime we have sets which does not
contain finite number of elements then also sometime we can represent using this roster form
so for example the set of all odd natural numbers can be represented by
so one is this smallest odd natural number then
the next one is three next one is five seven nine and then we put dot dot dot
so if we know a pattern then we
write the first few elements of the set and then we use dot dot dot to say that their infinitely many elements of this set there is one more the way of representing a set normally
so the second way to represent a set is
called the set builder form
so in this form the set is described by the characteristic property possessed by all the elements of the set
so for example if we look at
the previous example the set of the set a is equal to 2 4 6 8 10 is represented in set builder form as a is equal to
so we just write it is a
collection of all n such that n is a natural number divisible by to rand n is less than or equal to ten right
so there can be many different way
in which you can write the same set
so now let me introduce some of the sets that we use
in mathematics some notations which are used
so we will use this capital n to denote the set of all natural numbers
so set of all natural numbers is represented by
is capital n with one more vertical line here similarly we represent by z
this is set of all integers
so this includes positive negative
and zero all natural numbers will denote by q the set of all rational numbers
then r will be used for set of all real numbers
so set of all natural numbers
integers rational numbers real numbers capital c will denote the set of all complex numbers and then we can use if i write r plus this means set of all positive real numbers similarly q plus will mean set of all positive rationals
so next thing we will explain what is meant by the empty set
so the empty set is the set which
does not contain any elements
so the set containing no elements and the notation used for empty set is this phi or we use the curly
braces without any element inside the empty set is also called the null set or the void set
so if you see these terms they mean
the empty set itself
so for example i can describe a set let a equal to
so we have already introduced
this notation this means that this is this set containing all
n in natural number such that n is bigger than one and less than two
so suppose we write this set
so is is there any natural number which
is bigger than one and less than two no

so this set is empty because there is no natural number strictly between one and two another example suppose b
is the collection of all x in rational number such that x square is equal to two right
so you might have seen in high school
that there is no rational number whose square is equal to 2
so this set b is again
equal to the empty set let me also use a notation
so ok i will come to that later so
first let me define finite and infinite sets
so a finite set is a set which
contains only finitely many elements
so set is called a finite set if it contains only finitely many elements otherwise it is called and in finite set
so example the set a set of all vowels is a finite set because it contains only five elements but all these examples that i give
set of all natural numbers set of all integers rational numbers real numbers complex numbers these are in finite sets
so next thing we will say what
we mean by two sets to be equal
so two sets a and b are said to be equal if they contain exactly the same elements
so note that while representing a set the order of the elements is not important
so for example if a is equal to one two three and we write b equal to two three one then a and b are the same set because both a and b contains the same three elements one two and three
so so while writing sets its not important in
which order the the elements come
so next concept is of subsets
so let x be a set we say that a set capital a is a subset of x and this will be denoted by a subset of x if every elements of the set a is also an element of the set x
so this is usually denoted as a subset of x if a belonging to capital a this should imply
that a is also an element of capital x
so some examples of subsets of
the sets that we have seen
so note that the set of natural number this is a
subset of set of all integers right every natural number is also an integer set of
integer is a subset of set of rational numbers which is a subset of the set of real numbers which
includes rationals as well as irrational numbers and then once you learn complex numbers you see
that real numbers are subsets of complex numbers now one important point is that two sets a and b are equal if and only if a is a subset of b and b is a subset of a right
so a is equal to b this is equivalent to a subset of b and b subset of a right
so this is very simple thing to
see that because two sets are equal if they contain the same element
so every element in
a must be in b and vice versa
so a is a subset of b and b is a subset of a but this is very useful

when you try to prove that two sets are same you prove that each is the subset of the other
one there is another concept called power sets
so given a set a the power set of a is the collection of all subsets of a and the notation used for power set is p of a denotes the power set of a
so p of a this will consist of all
b such that b is a subset of a
so suppose a is equal to one two three a consists these
three elements one two three can you write down what is the power set of a
so first of all empty set is a subset of
every set
so empty set is in the power set then we list down all the sets which contains
all subsets of a which contains only one elements
so we have this set one the set
containing two the set containing three
so we got all the sets containing zero element
then all the sets containing one elements then you can list down all the sets which
contains two elements
so we have one two two three one three and then all the sets containing three elements we have one two three right
so this gives me all the subsets
of this set a containing three elements one two three now if you count down count how many elements are there
so here the number of elements in the power set is equal to eight which is equal to two cube
so for a set a we denote by this will denote the number of elements in a
so if we have if we have a set a containing n elements then the number of elements in power set of a this is always two to the power n why is this
so this is exactly like we did for the
special example containing three elements that when you are looking at the subsets
so if b is any subset of a then any particular element of a is either in b or its not in b right
so there are n elements and for each we get a subset by specifying whether it is in b or not
so therefore we have two
choices for each n elements and hence the number of such
subsets will be two to the n
so this kind of counting you will also learn
when you learn permutation and combination
so so now we will learn some operations on sets
so the first one is called union
so given two sets a and b the union of a and b this is denoted by a u b consists of all the elements which are either in a or in b and note that when we say something is either in a or in b it also includes elements
which are in both a and b right
so let me write this in notation
so a union b is this set of all x such
that x belongs to a or x belongs to b
so for example let a be the set containing one two and three b b the set containing two three four and five then a union b it must contain all the elements of a and all

the elements of b
 so we write one two three   and then we have four and five
 so maybe you should note that while representing a set we do not repeat the elements for this example you see 2 and
3 are occurring in both a and b   but when we write a union v we do not write two twice or three twice
 so another basic operation on set is intersection
 so if i have a and b are two sets then a intersection b this consists of all the elements all x such that x belongs to a and x belongs to b right
 so intersection this
consists of all elements which are common to a and b
 so for the previous example a is equal to
one two three and b is two three four five when we write a intersection b we look at all the elements which are in
both a and b one is in a but not in b so   one is not in a intersection b two is in
both a and b
 so two is in the intersection   three is again in both a and b
 so three is also in
the intersection then four and five are not in a   not in a
 so a intersection b consists
of only these two elements two and three a intersection b is the empty set then we say that a and b are disjoined
 so the next operation on set is the set difference
 so the notation is this or simply a minus b
 so what does this mean
 so the set difference
of a and b consists of all the elements   which are in a but not in b a minus b this
is equal to all x such that x belongs to a and x is not in b ok
 so for example a equal to one to three b is two three four five then a minus b we have to look at all the elements of a
which is not in b
 so one is in a and not   in b two and three are in a but they are in b also so we do not include this in the set difference similarly if you write b minus a you have to
write down all the elements of b which are not in   a
 so 2 and 3 are in a but 4 and 5 are not
in a
 so b minus a consists of 4 and five
 so note that i can write a union b is equal to a minus b union a intersection b sorry union with b minus a right
 so let me explain this by a venn diagram
 so if we have this as the set a
and this is set b then a minus b   consists of all the elements a in a which is not in b
 so that means that this is a minus b this one is a intersection b and this is b minus a
 so this is a minus b this part is a
intersection b and this one is b minus a
 so you can see that a union b can be written as
these unions and note that here the unions are   disjoint
 so there is no intersection

between these three parts a minus b   a intersection b and b minus a
so this one here is disjoint union
so this is something important again
to write the union of sets we can write   as union of disjoint sets by using this set difference and intersection   some other terminology
so singleton
sets this means set containing only one element um
so the set containing only one set containing
only zero the set containing only the alphabet a   these are singleton sets let me also
introduce what is called complement of a set
so let u be and universal set and a b a subset of u the complement of a in u is
so this is denoted by a prime this is equal to
all the elements which are in u but not in a compliment of a consists of all elements which are not in a
so to say complement we always have a bigger set
and a subset and then complement is with respect   to that bigger set which we call the universal
set
so for example if u is one two three four and a is the set containing two and three and a complement
is equal to the set containing one and four right   this is u minus the set a set difference
with set a
so we will stop here   in the next class we will discuss some more
properties of sets and then we will also   look at some of the problems
from the exercise thank you you