Welcome everyone. I am Dr.Madhavi Zilba Naik,

Title of the unit:Atomic structure.

Module name: Anomalous electronic configuration.

In this module, what we are going to learn, we will see

that in the outline: Aufbau principle, limitations of Aufbau"s

principle, anomalous electronic configuration and some

examples of elements showing anomalous electronic

configuration.

Learning outcomes: What students will learn from this

module. Students will be able to explain Aufbau principle, list

the limitations of Aufbau principle, identify the

anomalous electronic configurations and cite the

examples of elements displaying anomalous

electronic configuration.

So to begin with, we will first revise what is Aufbau principle.

For filling of electrons in orbitals. There are various

principles that we study such as Pauli's exclusion principle,

Hund's rule and Aufbau principle.

What Aufbau principle says is, electrons enter the orbitals available in the order of increasing energy. Energy of these orbitals is determined by quantum numbers, **n** which is a Principal quantum number and **l** which is the Azimuthal quantum number.

Orbitals are filled in increasing value of **(n+l)**

For orbitals with the same **(n+l),** orbital of lower value of **n** is filled first.

So if we see these orbitals.

We can arrange how these orbitals are arranged in the

energy levels. So here you can see the energy level of these

orbitals. You can see in this energy level diagram. The **1s** Orbital, **2s** orbital **2p** , **3s, 3p, 4s, 3d..**

and so on, so you can see that irrespective of the values that

are there, they are arranged as per their energy levels.

Now we will just solve a few examples according to the Aufbau principle.

where electron filling is done .So electronic

configuration of say a simple carbon atom. So Carbon has

atomic number 6. So you can see the electrons are filled

1s2, **2s2** orbital **2p2.** Another example,may be oxygen, which is having

atomic number 8. You can see **1s2**, **2s2** orbital **2p4.**

Now let us take one of the transition elements Vanadium, atomic number

is 23, so you have **Argon (18) 4s2 ,3d3** , So here you can

see that **4s** is a lower energy level than the **3d**.

These all elements are following the Aufbau principle.

(n-l)subshell and **ns** subshell lie very close

together. Yet former is somewhat higher in energy that we have

seen in case of **4s** and **3d** .Now according to this Aufbau

predicted the electronic configuration of the several

elements in the periodic table.Now this Aufbau principle also has certain limitations. Now what are those we will see now.

It cannot be used to predict electronic configuration of atoms on ionization. Now what is ionization, It is when an atom loses an electron and forms a cation,it is ionization. So Iron is an example we can take ,atomic number 26, electronic configuration **Argon (18) 4s2 ,3d6**. Now if we remove 2 electrons of iron making it **Fe2+** cation, the observed electronic configuration is **4s0 ,3d6** for outer electrons and not **4s2 ,3d4.**

As per Aufbau principle,since **3d** electrons are filled last, they could have been removed first, but that is not happening the electrons are removed from the **4s** orbital and this cannot be explained by Aufbau principle.

So actually what happens in the ionization is, the first electrons are lost from the subshell with higher **n** i.e your Principal Quantum number. If **n** is same then from subshell with highest Azimuthal Quantum number the electrons are removed.

Now this is a periodic table as we all know, all these elements, their electronic configuration as per Aufbau principle can

be written. Now you see I have highlighted certain elements in may be red or green. These are certain elements which show anomalous behavior, anomalous as in which is different from the normal expected. So we will see them in detail. Example of anomalous electronic configuration. In this table I have listed the first transition elements and if you carefully see the two elements are highlighted in red. Now why they are highlighted in red? If you can again see the electronic configuration, as per Aufbau principle it is different and what is observed is different. So Chromium which is having **4s2 3d4** as outer electronic configuration expected as per Aufbau principle.

But what is observed is **4s1 3d5 ,** whereas for copper, again **4s2 3d9** is as per Aufbau principle whereas what is observed **4s1 3d10.** Now why did this happen? Why this anomaly? Again, you can see carefully here when I have put these electrons in the orbital, First is the expected electronic configuration. Second is the observed electronic configuration. So in the expected electronic configuration you have seen **4s2 3d4** but in the observed it **4s1 3d5** so it becomes a half filled shell . when it

comes to copper you will see with the observed electronic

configuration it's a completely filled shell, so this is nothing

but the special stability that is associated with half filled and completely filled subshells
This is the reason they show this anomalous behavior.

Now, moving ahead with several other elements that also show

the anomalous behavior in this table. As you can see I have

also included chromium, copper along with certain other

elements. The elements which are highlighted in green are the one

which show this anomalous behavior because of either

attainment of half filled or completely filled shell.

whereas the other ones,which are either light or

which are marked with the red,are also showing anomalous

electronic configuration but due to different other reasons.

And what are these exceptions we will see in the next slide.
Just make a note of the elements that are highlighted in red.

So the exception was with Technetium and Tungsten.

Although these two elements in Aufbau electronic

configuration has have filled or completely filled electronic

configuration, yet they do not show that observed electronic

configuration,it is different, and this is because the complex

nuclear electron and electron electron forces, play a role in

determining this electronic configuration. So half filled or

completely filled orbitals is not the only criteria.

Next we have another exception which was palladium.

The observed configuration has two misplaced electrons, so

this is the only exception in the entire periodic table

wherein 2 electrons are misplaced for this exception

i.e for this exceptional anomalous behavior. Now again,

I have listed certain of the actinides and lanthanides,

which show anomalous behavior. Again, the one highlighted in

green are due to the half filled or completely filled

shell, whereas the other one has other reasons.

Now we will summarize what we have seen in this presentation.

According to Aufbau principle,electrons are added to orbitals

in the increasing order of their energy. Aufbau principle cannot

predict electronic configuration of atoms on ionization.

Anomalous electronic configuration is shown by

several elements. Extra stability is associated with half

filled and completely filled subshells.

(n-1) subshell and **ns** subshell lie close together.

Complex nuclear electron and electron electron forces play a role in determining electronic configurations.

These are the references, thank you.