Chem 1311Ch8Ep3 Transcript

00:00:00

Hello, and welcome to the third episode of periodic Trends.

00:00:10

Previously in periodic trends.

00:00:14

We learned the underlying reasons for both the Ionic and atomic size trends in the periodic table.

00:00:25

We practiced using these trends to predict relative size of ions and atoms.

00:00:37

In today's episode we will learn the trends for ionization energy and electron affinity and how they are related to atomic size.

00:00:54

I I.

00:00:54

Sensation energy is the minimum energy required to remove an electron from a gaseous atom in its ground state.

00:01:03

That basically means how hard you have to work to remove an electron.

00:01:12

From a gaseous atom.

00:01:18

This is the process.

00:01:21

And the energy required to remove the first electron is called the first ionization energy.

00:01:31

The energy required to remove the second electron.

00:01:36

Is the 2nd ionization energy.

00:01:41

The energy required to remove the third electron.

00:01:46

Is the third ionization energy, and so on.

00:01:49

You get the idea.

00:01:54

Regardless of the element.

00:01:57

The second ionization energy is always higher than the first ionization energy.

00:02:05

And the third ionization energy is always larger than the second one, and so on.

00:02:12

So for any atom.

00:02:14

The more electrons you take

00:02:17

The higher the ionization energy.

00:02:25

We can use this table of ionization energies to show that trend.

00:02:30

And a few other interesting features of the ionization energies.

00:02:46

Nitrogen, for example, has a first ionization energy of 1400 kilo joules per mole.

00:02:54

But each successive ionization energy increases.

00:03:03

This is also true of metals such as aluminum.

00:03:07

In which each successive ionization energy is always greater than the previous one.

00:03:15

If you look throughout the entire table, you will find absolutely no exceptions.

00:03:20

To this rule.

00:03:27

There is also a periodic trend for elements in the same group.

00:03:32

The first ionization energy decreases as you move down the group.

00:03:45

For example, in Group 1.

00:03:48

Lithium has the largest ionization energy.

00:03:54

In Group 2.

00:03:56

Beryllium has the greatest anticipation energy.

00:04:03

And in Group 18, helium has the greatest ionization energy.

00:04:11

So ionization energy.

00:04:14

Increases from bottom to top.

00:04:20

The reason for this observed trend has to do with the size of the atom.

00:04:26

One might have expected the opposite trend because the charge of the nucleus increases as you go down the group.

00:04:34

But the distance between the electron and the nucleus?

00:04:38

If a bigger factor.

00:04:40

The greater the distance, the smaller the force.

00:04:54

There is also a horizontal trend for the first ionization energy as you go across the period.

00:05:03

Notice that as the atom gets smaller from left to right, the first ionization energy increases just as we expected.

00:05:21

Both the horizontal and vertical trends for the first ionization energies of the representative elements.

00:05:28

Can be summarized by this diagram.

00:05:37

From left to right, the ionization energy increases.

00:05:40

from bottom to top, the ionization energy increases.

00:05:48

The smaller the atom.

00:05:50

The greater the ionization energy.

00:06:00

This graph shows the periodic trends also.

00:06:05

If you focus only on the noble gases.

00:06:09

You can see that the first ionization energy is the greatest for helium and steadily decreases as you move down the group.

00:06:21

You can choose any of the other groups and see the exact same trend.

00:06:28

Take your pick.

00:06:37

You can also see the horizontal trend if you focus on only one of the upward peaks.

00:06:50

This graph also shows 2 trend reversals for every period.

00:06:55

They always occur in the same place.

00:06:58

Where the piece of shell gets its first electron.

00:07:01

And where it gets its fourth electron.

00:07:10

There is one more thing to notice in this chart.

00:07:15

Using carbon as an example, notice that there is a huge jump in the 5th ionization energy and beyond.

00:07:24

The reason for this big jump is that much more energy is required to remove core electrons than it is to remove valence electrons.

00:07:35

Carbon has four valence electrons, so the 5th electron is the first core electron.

00:07:45

Aluminum shows the same jump after its third valence electron has been already removed because the 4th one will be.

00:07:55

A core electron.

00:07:59

And nitrogen shows the same jump after its 5th valence electron has been removed.

00:08:09

You may remember.

00:08:10

Nitrogen has five valence electrons, so the 6th.

00:08:15

It's a core electron.

00:08:24

Here we have a couple of questions concerning ionization energies.

00:08:28

Pause the video.

00:08:29

Write down your answers and then come right back.

00:08:39

Welcome back.

00:08:42

The first question is about the vertical trend.

00:08:47

The first ionization energy decreases down the group, so oxygen has the higher one and sulfur the smaller one.

00:08:58

So, the answer is sulfur.

00:09:05

The second ionization energy question for a lithium and beryllium is not a trick question.

00:09:13

It's just trickish.

00:09:17

Lithium has only one valence electron, and beryllium has two valence electrons.

00:09:25

The second electron that you remove from lithium.

00:09:28

Would be a core electron and, therefore.

00:09:32

Much higher than the second electron for beryllium.

00:09:39

So, lithium will be your answer.

00:09:50

Electron affinity is defined as the negative of an energy change so that the values are more intuitive.

00:09:57

An element with a high electron affinity.

00:10:00

Will be very eager to accept electrons.

00:10:08

This is the process.

00:10:10

Basically, the opposite of the ionization energy.

00:10:16

And like I just said.

00:10:25

Here's an example of electron affinity.

00:10:28

Fluorine has a high electron affinity because it is very willing to accept an electron.

00:10:39

Oxygen has a high electron affinity, just not as high.

00:10:43

As fluorine's

00:10:46

The larger the value of the electron affinity, the more willing the element is to accept an electron.

00:11:00

The trends for electron affinity and 1st ionization energy are the same.

00:11:09

Because smaller atoms are better able to accept an electron.

00:11:15

For the same reason that they are reluctant to part with one of their own.

00:11:26

Here are both the vertical and the horizontal trends for electron affinity.

00:11:33

And this table shows the values for those electron affinities.

00:11:41

You can see that the horizontal trend for electron affinity.

00:11:47

You will notice that the trend is not as clean.

00:11:51

As the ionization trend, because accepting an extra electron is also affected by the orbital availability.

00:12:00

After all, you have to put that electron somewhere.

00:12:06

The vertical trend is a little bit cleaner.

00:12:09

You probably have noticed a consistent drop in electron affinity after group 14 when looking at the horizontal trend.

00:12:20

Why do you think the members of Group 15?

00:12:25

Are less willing to accept an electron than those of groups 14 and 16.

00:12:34

What's going on there?

00:12:41

Do you want a hint?

00:12:43

OK, it matches the first ionization energy.

00:12:51

And it actually.

00:12:52

Matches both of them.

00:12:56

OK, our real hint this time.

00:13:00

Look at the electron configurations of the elements where the exception occurs.

00:13:16

And that's all there is.

00:13:18

There isn't any more.