Science 9 Unit 3.3 KEY

Name: Key

3.3 – The Periodic Table
Science 9, Wolfe

**Part 1: The Properties of Elements**

Back before we knew a thing about how to count protons or even see individual atoms or molecules, we could see that some things looked, felt, smelled, and tasted different from one another. We could see that some things, such as rocks, would sink in water and some things, such as most woods, would float in water. And we knew that some things, such as gold, were solid until you got them very very hot; some were liquid, and some could be both at regular temperatures – like water!

A **property** is just a characteristic of something – its size, shape, colour, etc.

*Watch the following videos for a little more explanation about properties:*

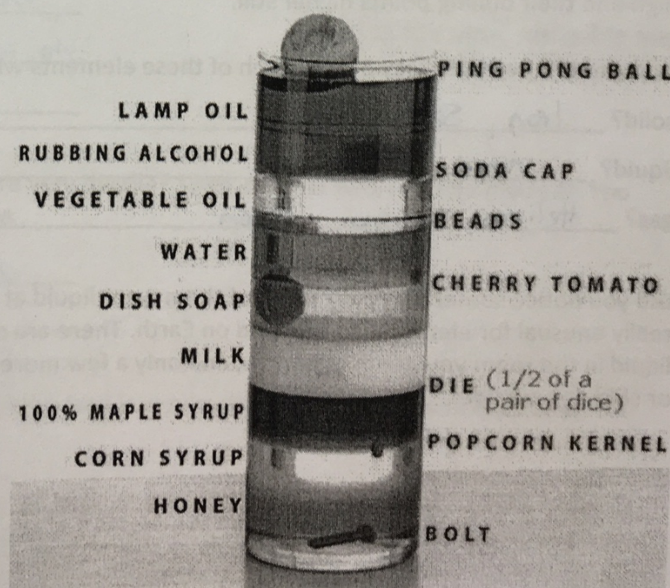
- *Organizing properties: Crash Course Kids #35.1* *https://www.youtube.com/watch?v=zD7W5O0BH7g*
- *What's my property? Crash course kids #35.2* *https://www.youtube.com/watch?v=nlSemv2fLN8*

Some properties are physical. You can see these with your eyes or measure them in the lab with basic tools such as rules and thermometers.

In chemistry, the **physical properties** we care about include things like:

**Density** – does it float or sink in water? How heavy does it feel?

This picture shows the density of various substances. Water is what we compare everything to, and in this diagram it is near the middle. Look at it to answer these questions:



Are oils more or less dense than water? less dense

What is the densest thing in this diagram? bolt

Why do you think honey and syrups are more dense than water? What ingredient do they all have in common, that water doesn't? they have a lot of sugar dissolved in

**Boiling point** – When does it turn from a liquid into a gas?
**Melting point** – when does it turn from a solid into a liquid?

Look at the following chart of some elements and their melting and boiling points:

| Element name (symbol) | Melting point (C) | Boiling point (C) |
|---|---|---|
| Helium (He) | -272 | -269 |
| Oxygen (O) | -219 | -183 |
| Argon (Ar) | -189 | -186 |
| Iron (Fe) | 1538 | 2861 |
| Silver (Ag) | 962 | 2162 |
| Tin (Sn) | 232 | 2602 |

The first three elements on the list are one we usually see as gases. You might notice that their boiling points are very low and there isn't much difference between melting and boiling.

The last three elements are all metals. You might notice that their melting points are all very high and their boiling points higher still.

At room temperature (say 20 C), which of these elements will be:

solid? Iron, Silver, tin

liquid? none

gas? Helium, oxygen, argon

Did you notice something odd? None of them were liquid at room temperature. It's actually really unusual for elements to be liquid on Earth. There are only six of them that would be liquid in the room you are in right now, and only a few more that would be liquid on a very hot or cold day outside!

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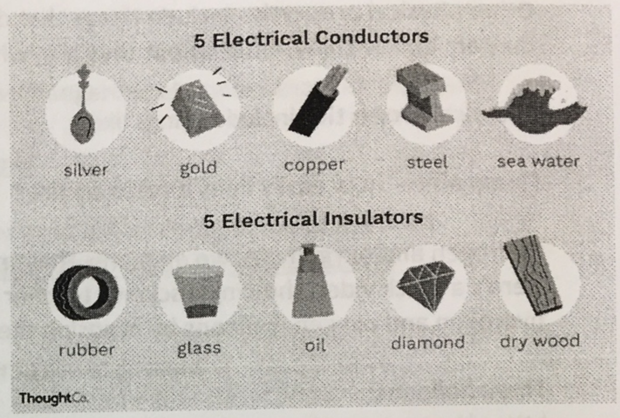
**Conductivity** – does electricity go through it?

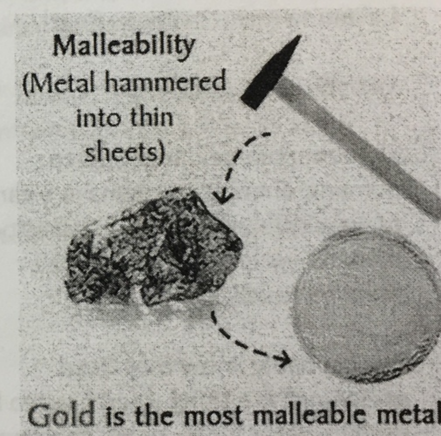



Remember way back when we looked at electricity? We found that metals are usually a good conductor, and air (a gas) is a poor conductor (or a good insulator.)

Notice on the conductor list, you have three metal elements (silver, gold, copper), one alloy which is 90% or more iron, and sea water – which isn't a single element at all.

The insulators are made up of mostly carbon, oxygen, hydrogen, and/or silicon. None of these are metals.

**Malleable & ductile** – can you squish it? Does it bend or break if you hit it with a hammer? Can you form it into a thin sheet or a long wire?




If you can hammer it into a thin sheet, it's malleable.
If you can make it into a wire, it's ductile.

Can you think of three elements that are very malleable Think of foil, cans, jewellery... anything that is pressed or hammered into shape.

(varies) aluminum, copper, tin, gold, silver, platinum, etc

Can you think of two elements that are very ductile? Think of what wires can be made of. You may repeat some answers from above.

copper, gold, silver, etc

These usually go together but not always – lead is very malleable, but it doesn't like being stretched.

Do you notice what every element you thought of above has in common? That's right, again we see metals doing their thing. The difference between metals and non-metals is something we will talk about again in the next section.

*Extras for enrichment:*

And just for kicks… Here's a video on some of most dangerous elements that can be found: "MOST DANGEROUS Table of the Elements" https://www.youtube.com/watch?v=tj05u6wuQmg

And going a little away from elements, Hank is ready to tell us about some of the most dangerous chemicals on Earth: https://www.youtube.com/watch?v=ckSoDW2-wrc

## Part 2: How elements are organized

By now, you may have figured out that there are whole lot of different elements, from hydrogen – the smallest one known, which consists of only a lonely little proton with an electron circling around it – to the superheavy elements, which only exist in a lab and might be so radioactive they only live for part of second before turning into something else!

Take a look at the "Periodic Table of the Elements, in Pictures" (attached on the back of this packet). This is great table that includes not only the science information we will learn about but also an example of where me find or use each one!

Look down the right side of the table. The number of the element is in the upper right of each box. What are the names of the elements numbered?

#10 ~~Nickel~~ Neon

#18 Argon

#36 Krypton

#54 Xenon

What do they all have in common? They are all used for lights + lamps of some kind. . Hmm… they are all in the same column, and they all have really similar uses. Is this just a coincidence?

The periodic table isn't just organized by number – there's a reason it has that weird shape at the top and a reason it's as wide as it is! In fact, when the Periodic Table was created, no one even knew atoms could be broken down into smaller parts. The elements were organized by their properties – the way they looked and behaved – and it was only much later that we found out the way their electrons were arranged was responsible for most of those properties.

Watch the following video to learn a bit more about how the periodic table was created and why it's drawn like that:

"The genius of Mendeleev's periodic table" https://www.youtube.com/watch?v=fPnwBITSmgU

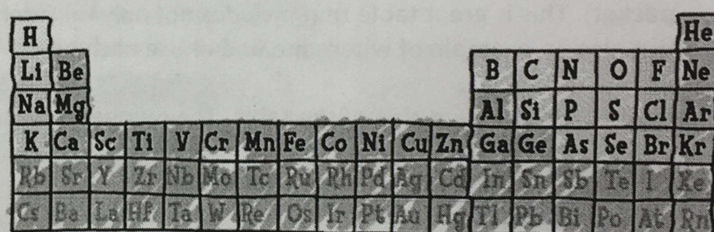
But how do we organize the periodic table today? The text in this section will go over this, and this video will show you in detail how it works and how we classify elements. It's 14 minutes long and has quite a bit of information, and you can watch it either BEFORE or AFTER reading the section:

"The Periodic Table Explained" https://www.youtube.com/watch?v=uPkEGAHo78o

*The text below is adapted from* http://www.chem4kids.com/files/elem_intro.html

**Periodic Table and the Elements**

Now we're getting to the heart and soul of the way the Universe works. You know that a generic atom has some protons and neutrons in the nucleus and some electrons zipping around in orbitals. When those pieces start combining in specific numbers, you can build atoms with recognizable traits.




If you have eight protons, neutrons and electrons, you will have an oxygen (O) atom.

If you have seven protons, neutrons, and electrons, you will have a nitrogen (N) atom.

If you have 14 protons, neutrons, and electrons, you will have a Silicon atom (check your periodic table!)

If you have 74 protons, neutrons, and electrons, you will have a tungsten atom.

And if you have Six protons, neutrons, and electrons, you know you have a carbon (C) atom!

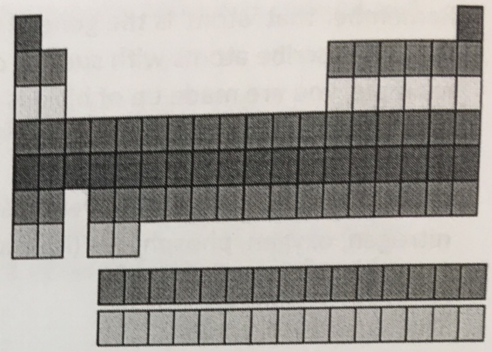
The atoms for each element are unique, even though they are all made of similar subatomic parts. The way they are arranged – especially the electrons – affects all of their properties and makes them different from atoms of another element.

After that, a second row starts. How many elements are in the second row? ___8___

How many are in the third row? ___8___

Each of those electron shells, or orbitals, can hold up to eight electrons.

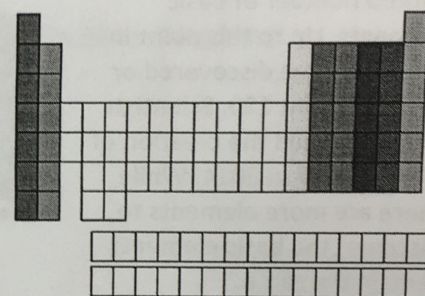
The fourth row, or period, is ___18___ elements across. The fourth electron shell can hold that many electrons! Get it?



PERIODS ALONG HORIZONTAL ROWS

...and Your Groups

Now you know about periods going left to right. The periodic table also has a special name for its vertical columns. Each column is called a **group**. The elements in each group have the same number of electrons in the outer **orbital**. Those outer electrons are also called **valence electrons**. They are the electrons involved in chemical bonds with other elements.



GROUPS ALONG THE VERTICAL COLUMNS

Every element in the first column (group one) has one electron in its outer shell.
Every element in the second column (group two) has two electrons in the outer shell.
As you keep counting the columns, you'll know how many electrons are in the outer shell. There are exceptions to the order when you look at the transition elements, but you get the general idea.

For example, Lithium (Li) has the atomic number 3. This means is has ___3___ protons and ___3___ electrons. Since we filled up the first shell (with two electrons), there is one left over to start the next. Lithium has ___1___ valence electron.

The atomic number tells you there are seven ~~electrons~~ protons in a neutral atom of nitrogen. How many electrons does it have total? ___7___ How many are in its outer orbital? ___5___

Take a much "larger" element, Zinc (Zn.) Find it on the periodic table:

Atomic number: ___30___

Total number of electrons: ___30___

Electrons in valence shell: ___12___

Why does the number of valence electrons matter? Because it affects the element's behaviour.

Atoms really like to have a full valence shell. The last column on the periodic table (Column 18) is known as the "noble gases". The elements are so happy just being by themselves that they rarely mix to form compounds (so they're called noble, like they are rich folks that don't have to hang out with the rest of us.)

Atoms just to the left of the noble gases have one electron less than a full valence shell. They are desperate to find that last electron.
The name of this column is ___halogens___. Fluorine, chlorine, bromine, and other halogens will easily form bonds with other elements to make different compounds. This way, they get that extra electron to fill their valence shell...

In the first two periods, atoms only have one or two valence electrons. These elements have an extra electron or two and like to bond with elements that are missing electrons. They "donate" an electron to someone else's valence shell to get rid of the extra. What are column 1 and 2 called?
___alkali metals___ and ___alkali earth metals___

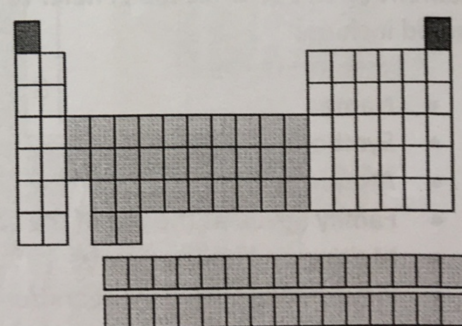
We usually don't bother talking about the other groups by name too much. Their behaviour is a little more complicated and something you will get into if you take Chemistry.

The main thing to remember is that atoms with the same number of electron shells, or orbitals, are in the same ___period___ (row in the periodic table) and atoms with the same number of valence electrons are in the same ___group___ (column in the periodic table.)

**Two at the Top**

Hydrogen (H) and helium (He) are special elements. Hydrogen, in its neutral form, does not have a neutron. There is only one electron and one proton.

Helium (He) is different from all of the other elements. It is very stable with only two electrons in its outer orbital (valence shell). Even though it only has two electrons, it is still grouped with the noble gases that have eight electrons in their outermost orbitals. The noble gases and helium are all "happy," because their valence shell is full.



HYDROGEN AND HELIUM AT THE TOP