



The Periodic Table of Elements

1. And now a song about elements

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2. And now Bill Nye: Atoms-Part 3

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Dmitri Mendeleev (1834-1907)



- A Russian chemist attempted to organize the elements based on information such as density, appearance, atomic mass, and melting point.
- After much work he determined that there was a **repeating pattern** to the properties when the elements were arranged in order of increasing atomic mass.

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Periodic Table of Elements
based on Mendeleev's Periodic Law

0	I	II	III	IV	V	VI	VII	VIII
He 4.00	Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0	
Ne 20.2	Na 22.99	Mg 24.31	Al 26.98	Si 28.09	P 30.97	S 32.06	Cl 35.45	
Ar 39.95	K 39.10	Ca 40.08	Sc 44.96	Ti 47.88	V 50.94	Cr 52.00	Mn 54.94	Fe 55.85
	Cu 63.55	Zn 65.38	Ga 69.72	Ge 72.64	As 74.92	Se 78.96	Br 79.90	
Kr 83.80	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc (98)	Ru 101.07
	Ag 107.87	Cd 112.41	In 114.82	Sn 118.71	Sb 121.76	Te 127.60		Rh 102.91
Xe 131.29	Ce 140.12	Ba 137.33	La 138.91	Hf 178.49	Ta 180.95	W 183.84	Re 186.21	Os 190.23
	Au 196.97	Hg 200.59	Tl 204.38	Pb 207.2	Bi 208.98	Po (209)	At (210)	Ir 192.22
Rn (222)	Fr (223)	Ra (226)	Ac (227)	Th (232)	Pa (231)	U 238.03		Pt 195.08

Legend:
 Dobereiner's triads
 Known to Mendeleev
 Lanthanide series
 Actinide series
 Known to Ancients

- In this order, certain chemical properties of the elements were "**periodic**" meaning that they had a regular repeated pattern.
- There were still some missing elements, but he predicted that those were elements yet to be discovered.



- In 1914 **Henry Moseley** determined that the elements should be arranged by the number of **protons** - the **atomic number** - and the periodic table was rearranged using this method, which greatly improved the arrangement of elements.

The Periodic Table of the Elements

Each square on the table includes an element's name, chemical symbol, atomic number, and atomic mass.

Atomic number: 6
Chemical symbol: C
Element name: Carbon
Atomic mass: 12.0

The background color indicates the physical state of an element at room temperature. Carbon is a solid.

The color of the chemical symbol indicates the physical state of an element at room temperature. Carbon is a solid.

This zigzag line separates the metals from the metalloids, and metalloids from the nonmetals.

The names and symbols of elements 110-112 are unknown. They are based on the atomic number of the element. The official name and symbol will be approved by an international committee of scientists.

A series of elements is called a period.

A column of elements is called a group or family.

These elements are placed below the table to allow the table to be narrower.

A number in parentheses is the mass number of the most stable isotope of that element.

Periodic Table Humor

Early chemists describe the first dirt molecule

3. The Periodic Table & Elements

You can find this video and ALL The videos for this powerpoint In the chp 13 video library Found in the directory.

You've got your Periods..


- Periods = rows From left to right
- What do elements in a row have in common?
 - the same number of **electron shells**
- Every element in Period 1 (1st row) has 1 shell for its electrons (H & He)
- All of the elements in period 2 have two shells for their electrons.
- It continues like this all the way down the table
- The elements in a row become less metallic from left to right

And You've got your groups

- Column = group = **families**
- What do elements in a group have in common?
 - same number of **valence electrons** (electrons in the outer shell)
- Every element in group 1 (1st column) has 1 valence electron
- Every element in group 2 has 2 valence electrons.
- In fact, if you know the group's number, you automatically know how many valence electrons it has!

Group Labels

- Labeling the groups can be confusing because the rules change with the middle transition elements.
- The transition elements get grouped together as the "B" elements, or groups #1B - 8B.
- All of the other elements are "A" elements, with groups #1A - 8A.
- Using this labeling system will tell you exactly how many valence electrons are in the atoms.
- However, sometimes the groups are just labeled #1-18.




Two at the Top

- **Hydrogen** (H) and **helium** (He) are special elements.
- Hydrogen can have the talents and electrons of two groups, one and seven.
- Sometimes it is missing an electron, and sometimes it has an extra.
- Helium is different from all of the other elements.
- It can only have two valence electrons
- Even though it only has two, it is still grouped with elements that have eight.



Hydrogen: stands alone


- Gas,
- reactive,
- 1 electron in outer level.
- Hydrogen does not match properties of any single group so it is placed above Group 1.
- It can give it's electron away with ionic bonding, or share it's electron in covalent bonding



4. Hydrogen Reaction

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Periodic Table of Videos: <http://www.periodicvideos.com/>



Finding your way around the Periodic Table: 3 classes of elements

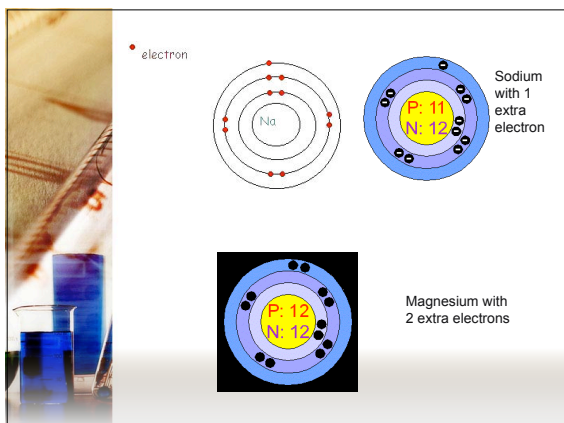
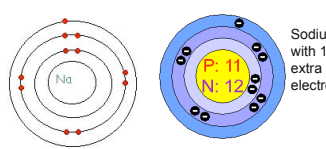
Metals

Metals are elements that are shiny and are good conductors of thermal energy and electric current. They are easily shaped into different forms because they are *malleable* (they can be hammered into thin sheets) and *ductile* (they can be drawn into thin wires). Iron has many uses in building and automobile construction. Copper is used in wires and coins.




Lead
Copper
Tin

Atoms of most metals have few electrons in their outer energy level

electron

Sodium with 1 extra electron



Magnesium with 2 extra electrons




Nonmetals

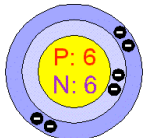
Nonmetals are elements that are dull (not shiny) and that are poor conductors of thermal energy and electric current. Solid nonmetals tend to be brittle and unmalleable. Few familiar objects are made of only nonmetals. The neon used in lights is a nonmetal, as is the graphite (carbon) used in pencils.



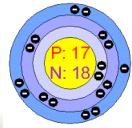
Bromine
Sulfur
Neon

Atoms of most nonmetals have an almost complete set of electrons in their outer level






Carbon: In need of 4 electron to have a full outer level




Chlorine only needs 1 electron to have a full outer energy shell

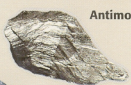


Metalloids


Metalloids, also called semiconductors, are elements that have properties of both metals and nonmetals. Some metalloids are shiny, while others are dull. Metalloids are somewhat malleable and ductile. Some metalloids conduct thermal energy and electric current well. Other metalloids can become good conductors when they are mixed with other elements. Silicon is used to make computer chips. However, other elements must be mixed with silicon to make a working chip.



Silicon




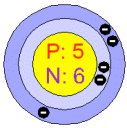
Antimony



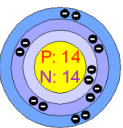
Boron

Atoms of metalloids have about a half-complete set of electrons in their outer energy level







Boron: In need of 5 electrons




Silicon: In need of 4 electrons




19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr



22
Ti
Titanium
47.9



32
Ge
Germanium
72.6




35
Br
Bromine
79.9

Elements at the left end of a period, such as titanium, are very metallic in their properties.

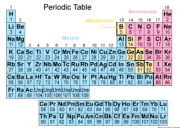
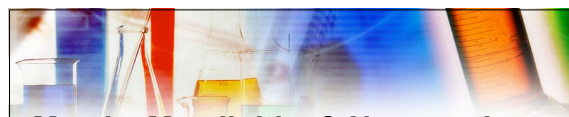
Elements farther to the right, like germanium, are less metallic in their properties.

Elements at the far right end of a period, such as bromine, are nonmetallic in their properties.



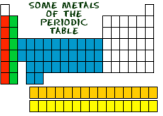
Metals, Metalloids, & Nonmetals

- Another pattern we find on the periodic table is that all of the metals are grouped together on the left & the nonmetals are on the right.
- The metalloids fall in between, near the zigzag line.
- This trend isn't a coincidence.
- The number of **valence electrons**, or electrons in the outer shell, determines how an element acts.

Metals, Metalloids, & Nonmetals

- For example, all of the metals have **few** valence electrons.
- This causes them to possess metallic properties such as, conductivity & reactivity.
- Conversely, the nonmetals on the right of the periodic table have **almost** complete sets of electrons in their outer level.
- Therefore, they possess nonmetallic traits such as dullness, poor conductivity, and brittleness.



Metals, Metalloids, & Nonmetals

- We can summarize all of this just by saying:
- Elements get less metallic as you move from left to right.

Elements at the left end of a period, such as titanium, are more metallic in their properties.

Elements farther to the right, like germanium, are less metallic in their properties.

Elements at the far right end of a period, such as bromine, are nonmetallic in their properties.

Families Stick Together

- Scientists group families of elements by their **chemical properties**.
- Each family reacts a different way with the outside world.
- BUT**, elements within a family are similar to one another.
- Metals behave differently than gases and there are even different types of metals.
- Some don't react, others are very reactive, and some are metallic.
- Let's go over the periodic table families...

Family #1 or 1A: Alkali Metals

- Li, Na, K, Rb, Cs, Fr
- Very** Reactive
- 1 valence electron
- All have ONE outer electron to lose.
- Sodium is used in street lights, and different compounds are used in detergent, paper, glass & soap.
- This makes them highly reactive, since they are looking to combine with another element to become stable and have that outer level filled and complete (or happy!).
- They are the most reactive of all metals
- These are also soft and can be cut with a knife.

Family #2 or 2A: Alkaline Earth Metals

- Be, Mg, Ca, Sr, Ba, Ra
- very** reactive, but less than alkali metals
- 2 valence electrons
- Not as reactive because it is harder to give two electrons away than just one.
- Potassium is used in fertilizer and with chloride.
- These elements are typically what are lost in perspiration which is why people buy special sport drinks that contain these elements!
- Calcium is in milk
- Magnesium is in Fireworks.

Family #3-12 (1B-8B): Transition Metals

- 1-2 valence electrons
- Less** reactive than alkaline earth metals because they don't give away their electrons as easily
- In these "short families" the properties are very much alike.
- Most have high melting points and are hard.
- Have 1 or 2 properties like the alkali or alkaline earth families.
- Group 11 = The **Copper** Family: are the coinage metals (Cu, Ag, Au) used to make currency

Family #3-12 (1B-8B): Transition Metals

- Lanthanide** Series:
 - 15 elements that start with lanthanum (La) at atomic number 57 and finishing up with lutetium (Lu) at number 71
 - shiny reactive metals
 - Most found in nature
- Actinides** Series:
 - 15 elements that start with actinium (Ac) at atomic number 89 and finishing up with lawrencium (Lr) at number 103.
 - radioactive and unstable
 - Most are man-made & not stable in nature

Group 13: The Boron Group

- One metalloid and 4 metals
- B, Al, Ga, In, Tl
- 3 electrons in the outer energy level
- Reactive
- **Solid** at room temperature
- Most common element in this group is **aluminum**

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

- Boron is most commonly found as borax and boric acid, which are used in cleaning compounds.
- Aluminum is the third most common element in the earth's crust. It is used as a coating agent, to prevent oxidation. It is an excellent conductor of electricity and heat and can be found in many cooking utensils.

#14 or 4A: Carbon Family

- C, Si, Ge, Sn, Pb
- 1 metal, 1 metalloid, and 2 nonmetals.
- 4 valence electrons
- No other group has a greater range of properties.
- They have the unique ability to form chainlike compounds.
- This family is incredibly important in the field of **technology**.

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

#15 or 5A: Nitrogen Family

- N, P, As, Sb, Bi
- 2 nonmetals, 2 metalloids, 1 metal
- 5 valence electrons
- Reactivity varies

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

#16 or 6A: Oxygen Family

- O, S, Se, Te, Po
- 3 nonmetals, 1 metalloid, 1 metal
- 6 valence electrons
- reactive
- Most members form covalent compounds
- Must share 2 electrons with other elements to form compounds.
- Oxygen is one of the most reactive nonmetallic elements.

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

Family #17 or 7A: Halogens

- F, Cl, Br, I, At
- **very** reactive
- **nonmetals**
- 7 valence electrons
- They are very reactive because have 7 valence electrons, this means they are ALMOST full and can combine with many elements.
- Halogen elements combine with metals to form compounds called **salts**.
- Halogen means "salt-producer".
- They combine with a metal by ionic bonding.
- They are the most reactive of the nonmetals families.
- As you move down the column, the elements get less reactive.
- A halide is when a halogen combines with another element (NaCl)

THE HALOGEN GROUP

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

Family #18 or 8A: Noble Gases

- He, Ne, Ar, Kr, Xe
- Nonmetals
- NON REACTIVE gases
- NO bonding with other elements
- 8 valence electrons (except He which only has 2)
- With the exception of He, these elements have 8 electrons in their outer energy level.
- Very stable
- They are **inert**, meaning they don't react with anything.
- Why? Because they're happy!
- All of these elements have full outer shells
- Colorless, odorless gases at room temperature
- Often used in neon products/neon lights
- All are found in Earth's atmosphere
- Only in laboratories can scientists force these to bond with other elements.

THE INERT GASES (NOBLE GASES)

The Chemical Families

Transition Elements

The Lanthanoid Series

The Actinoid Series

5. Chemical Music Video

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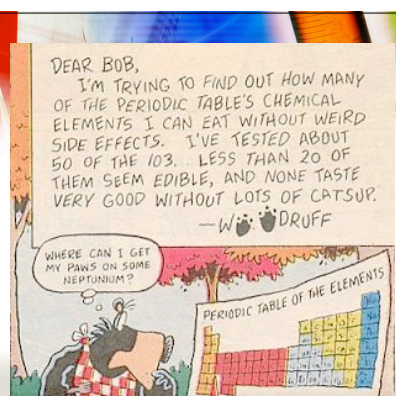
And now a word from Brainpop

- The Periodic Table of Elements:
- [Brainpop](#)

• BrainPop Answers

- 1. A
- 2. B
- 3. A
- 4. B
- 5. B
- 6. A
- 7. B
- 8. C
- 9. B
- 10. B

More Periodic Table Humor



6. Meet The Elements

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Little Book Work

- We're going to take some class time to get you going on your little book pages, but before we do that, I want to go over exactly what you find in the periodic table boxes and how that information is going to help you complete your work

The Periodic Table

Periodic Table of the Elements

The image shows a standard periodic table with elements color-coded by groups. It includes the title 'Periodic Table of the Elements' and a legend for 'Symbol' and 'Name'.

The #1 Element: Hydrogen

1 ← ATOMIC NUMBER
 — number of electrons
 — number of protons

H ← SYMBOL/NAME

1.01 ← ATOMIC MASS
 — 1.01 AMU (atomic mass units)

- Look at hydrogen.
- It's atomic number is 1, which means it has 1 proton in the center of the atom.
- Because the atom should be neutral, we need to add 1 electron to the outside.
- The two opposite charges cancel and we're left with one happy, neutral atom.

Hydrogen

The diagram shows a central nucleus with one red proton (+) and one blue electron (-) orbiting it.

The Periodic Table

Periodic Table of the Elements

The image shows a standard periodic table with elements color-coded by groups. It includes the title 'Periodic Table of the Elements' and a legend for 'Symbol' and 'Name'.

Let's make a Helium!

2 ← ATOMIC NUMBER
 — number of electrons
 — number of protons

He ← SYMBOL/NAME

4.00 ← ATOMIC MASS
 — 4.00 AMU (atomic mass units)

- **Step 1:** Have 2 protons
 — (since the atomic # is 2)
- **Step 2:** Have 2 neutrons
 — (since the 2 protons repel one another, the nucleus is unhappy & needs some inner peace)
- **Step 3:** Have 2 electrons (-2)
 — (since we want a happy atom & we need two negatives to balance the two positives)

A Helium Atom

The diagram shows a central nucleus with two red protons (+) and two green neutrons (0) orbiting by two blue electrons (-).

The Periodic Table

Periodic Table of the Elements

The image shows a standard periodic table with elements color-coded by groups. It includes the title 'Periodic Table of the Elements' and a legend for 'Symbol' and 'Name'.

- Let's look at this Helium atom again.
- So far you've learned about:
 - Atomic Number
 - Symbol/Name
 - The element's family
- What's this atomic mass thing???
- It's the total of the protons & neutrons in the nucleus. (remember: electrons are so tiny we give them a 0 (zero) mass)
- Atomic Mass is the number of **protons + neutrons**.

The diagram shows a Helium atom with a central nucleus of two protons and two neutrons, and two orbiting electrons. A green circle highlights the atomic mass '4.00' on the periodic table.

Go to your Little Book Page 6

The Atoms Family Atomic Math Challenge

8 O Oxygen 15.999	← _____ ← _____ ← _____ ← _____	Atomic number equals the number of _____ or _____ Atomic mass equals the number of _____ + _____
----------------------------	--	--

Little Book Pg 6

The Atoms Family Atomic Math Challenge

8 O Oxygen 15.999	← _____ ← _____ ← _____ ← _____	Atomic number equals the number of _____ or _____ Atomic mass equals the number of _____ + _____
----------------------------	--	--

8 = Atomic number
Atomic Number equals the number of: **Protons or Electrons**
 O = element symbol
 Oxygen= element name
 15.99= Atomic Mass (average!)
Atomic Mass equals the number of:
Protons + Neutrons

Now YOU try it! Pg 6 Oxygen

Complete the empty blanks!

8 O 15.999	_____ Oxygen (element name) Atomic # (number) = <u>8</u> Atomic Mass = <u>16</u> (round it) (Protons+Neutrons) # Protons: <u>8</u> (the atomic number) # Neutrons: <u>8</u> (the atomic mass - #protons) # Electrons: <u>8</u> (# of Protons = # of electrons)
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Atomic # = _____
 Atomic Mass = _____
 # of Protons = _____
 # of Neutrons = _____
 # of Electrons = _____

Now YOU try it! Pg 6

Complete the empty blanks!

30 Zinc 65.39	_____ Zn (element symbol) Atomic # (number) = <u>30</u> Atomic Mass = <u>65</u> (round it) (Protons+Neutrons) # Protons: <u>30</u> (the atomic number) # Neutrons: <u>35</u> (the atomic mass - #protons) # Electrons: <u>30</u> (# of Protons = # of electrons)
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Atomic # = _____
 Atomic Mass = _____
 # of Protons = _____
 # of Neutrons = _____
 # of Electrons = _____

Little Book: Page 8 Atomic Math

This is similar to the last part on your lecture notes

Element	Atomic #	Atomic Mass	Protons	Neutrons	Electrons
Hydrogen			1		
	9				
		23			11
Chlorine		56	26		
					47
		195			
Radon	90				

Remember what you've learned!
 Atomic Number = _____
 # Protons AND # Electrons
 Protons = Electrons
 Atomic Mass - Protons = # of neutrons
 Protons + Neutrons = Atomic Mass
 Valence Electrons? Look at the group number

Atomic Math

Using the periodic table, & the information just learned to complete this chart

Element	Atomic #	Atomic Mass	Protons	Neutrons	Electrons
Hydrogen	1	1	1	0	1
	9				
		23			11
Chlorine		56	26		
					47
		195			
Radon	90				