Chapter 3
Atoms and the Periodic Table

Mrs. Valentine

Physical Science

4th and 6th Periods

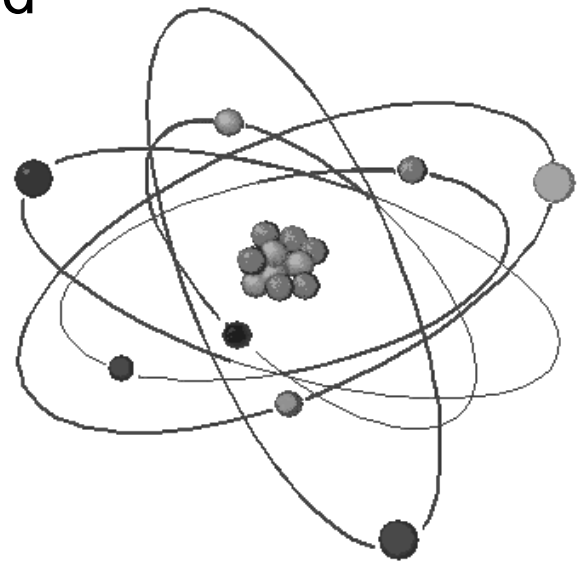
Section 1
Inside an Atom

- The differences in melting and boiling points are caused by the kinds of chemical bonds holding the atoms together.

- What does the inside of an atom look like?

- An atom consists of a nucleus surrounded by one or more electrons.

- **Definition:** Nucleus – the tiny, central core of an atom. The nucleus contains protons and neutrons.

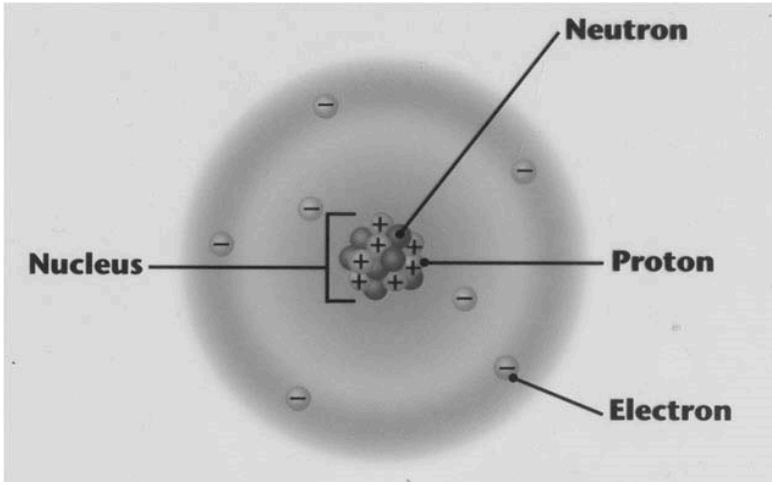


Structure of an Atom

- **Definition:** Proton –
  positive electrical charge (indicated by a + symbol).

- **Definition:** Neutron – a particle in the nucleus with no electrical charge. They are neutral.

- In the atom, there are also tiny particles that move around the nucleus.

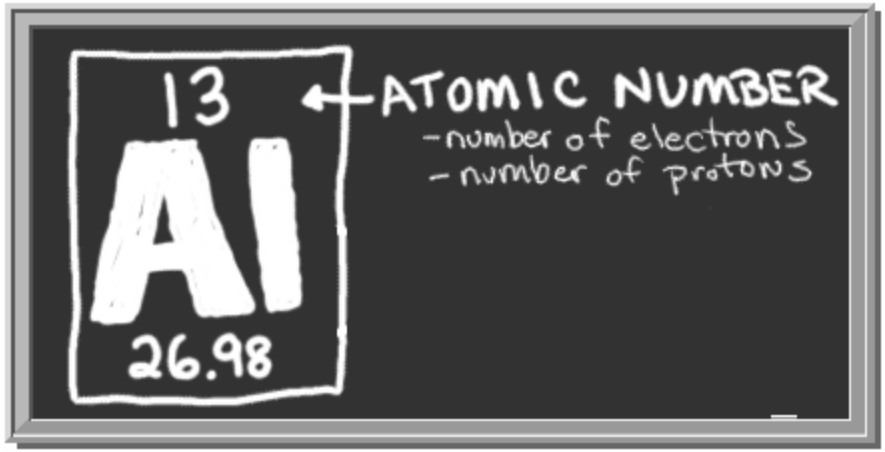


- **Definition:** Electron – a particle moving around the nucleus with a negative electric charge (indicated by a - symbol).

Atomic Number

- Every atom of a particular element contains the same number of protons.

- **Definition:** Atomic Number – the number of protons in an atom's nucleus. This is a unique property that defines an element.



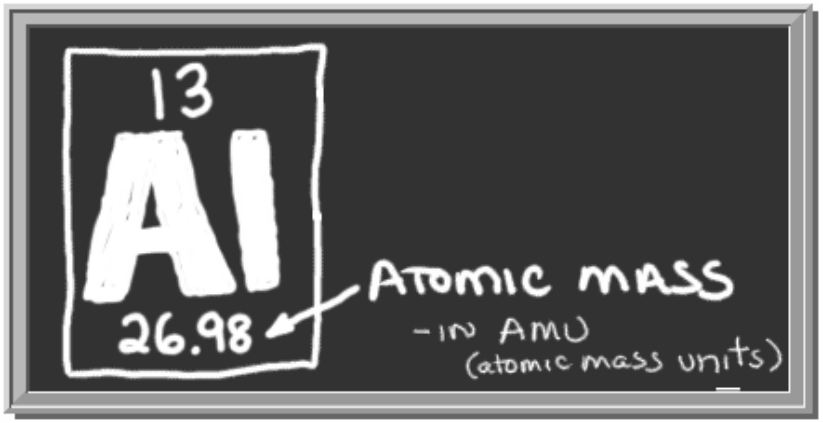
- For example, the atomic number for carbon is 6.

Atomic Mass

- Atoms cannot be measured with everyday units of mass because they are so small.

- **Definition:** Atomic Mass Unit (amu)– the unit of relative mass used to measure atoms. 1amu = 1.660540 x10^{-27} kg.

- A proton or neutron is about 1amu.

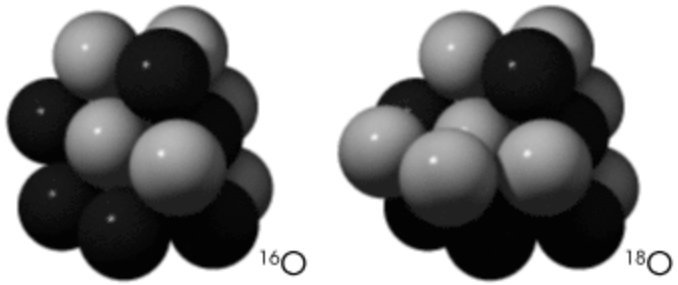


- An electron is about 1/2000amu.

- This means that the mass of an atom is mainly in the nucleus.

Atomic Mass

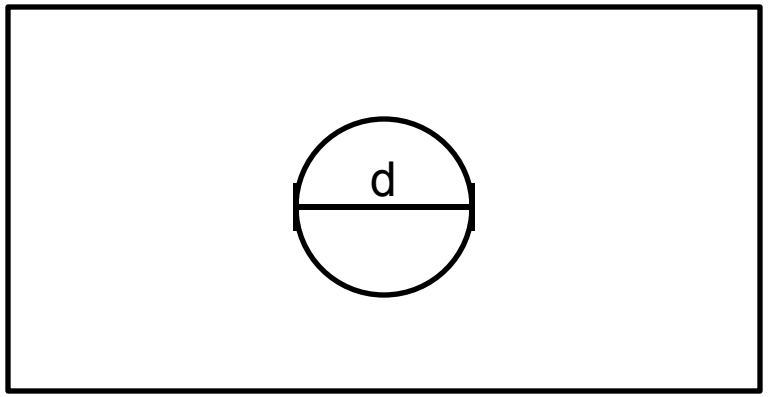
- Even though every atom of an element has the same number of protons, the number of neutrons may vary.
- This is called an isotope.
- For example, while all oxygen atoms have 8 protons, the different isotopes may have 8 or 10 neutrons.



- This means that the oxygen atoms do not always have the same mass.

Demonstration – Atomic Size

- On your desk, you have a ruler, a penny and a piece of paper. Trace the penny onto the piece of paper with a pencil.
- Measure the diameter in cm. Write this down on the slip of paper.

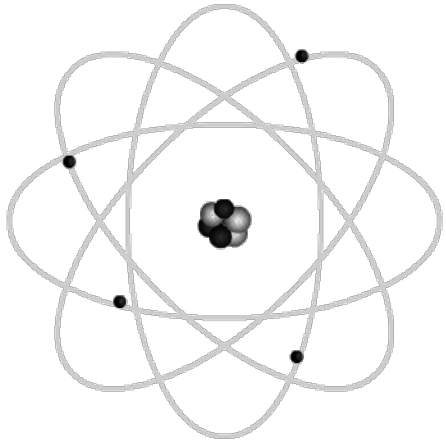


- How big do you think an atom would be with a nucleus the size of the penny?
- The atom would have a diameter of 1900m (about 1.18miles).

The Role of Electrons

- An electron moves so fast around the nucleus that it is impossible to know EXACTLY where it is at a given time.

- The space around the nucleus is like a spherical cloud of negatively charged electrons.

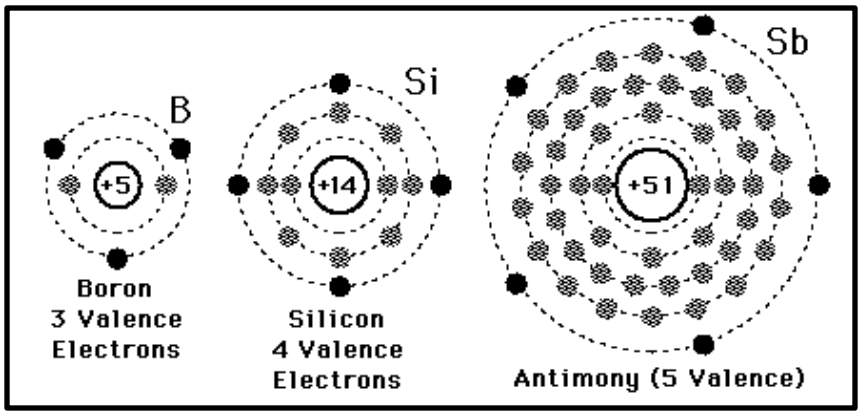


- Even though most of the mass of an atom is in its nucleus, most of it's volume is the space in which the electrons move.

- What can we infer from this about the nucleus?

Valence Electrons

- **Definition:** Valence Electrons – the electrons farthest away from the nucleus. These electrons are involved in the formation of chemical bonds.

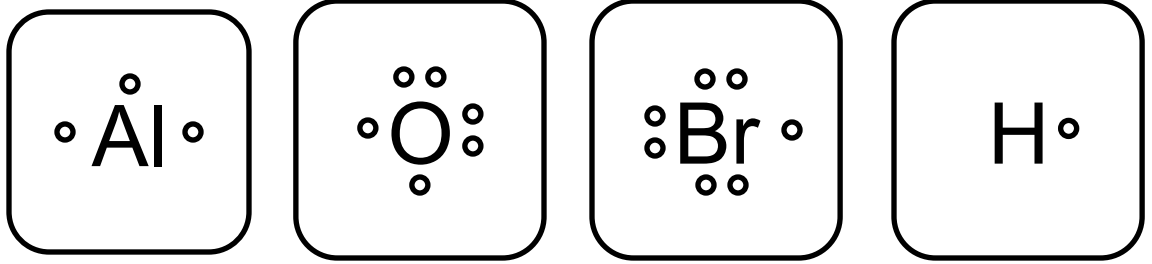


- A chemical bond forms between two atoms when valence electrons move between them. The valence electrons may be transferred from one atom to another, or they may be shared between atoms.

- This causes the atoms to become connected, or bonded.

Valence Electrons

- The number of valence electrons for an atom can vary from one (1) to eight (8).
- Examples –
  -
  -
  -
  -
- **Definition:** Electron Dot Diagram – made up of the symbol for an element surrounded by dots. Each dot stands for one valence electron.



Practice Problems

- Give electron dot diagrams for the following elements:

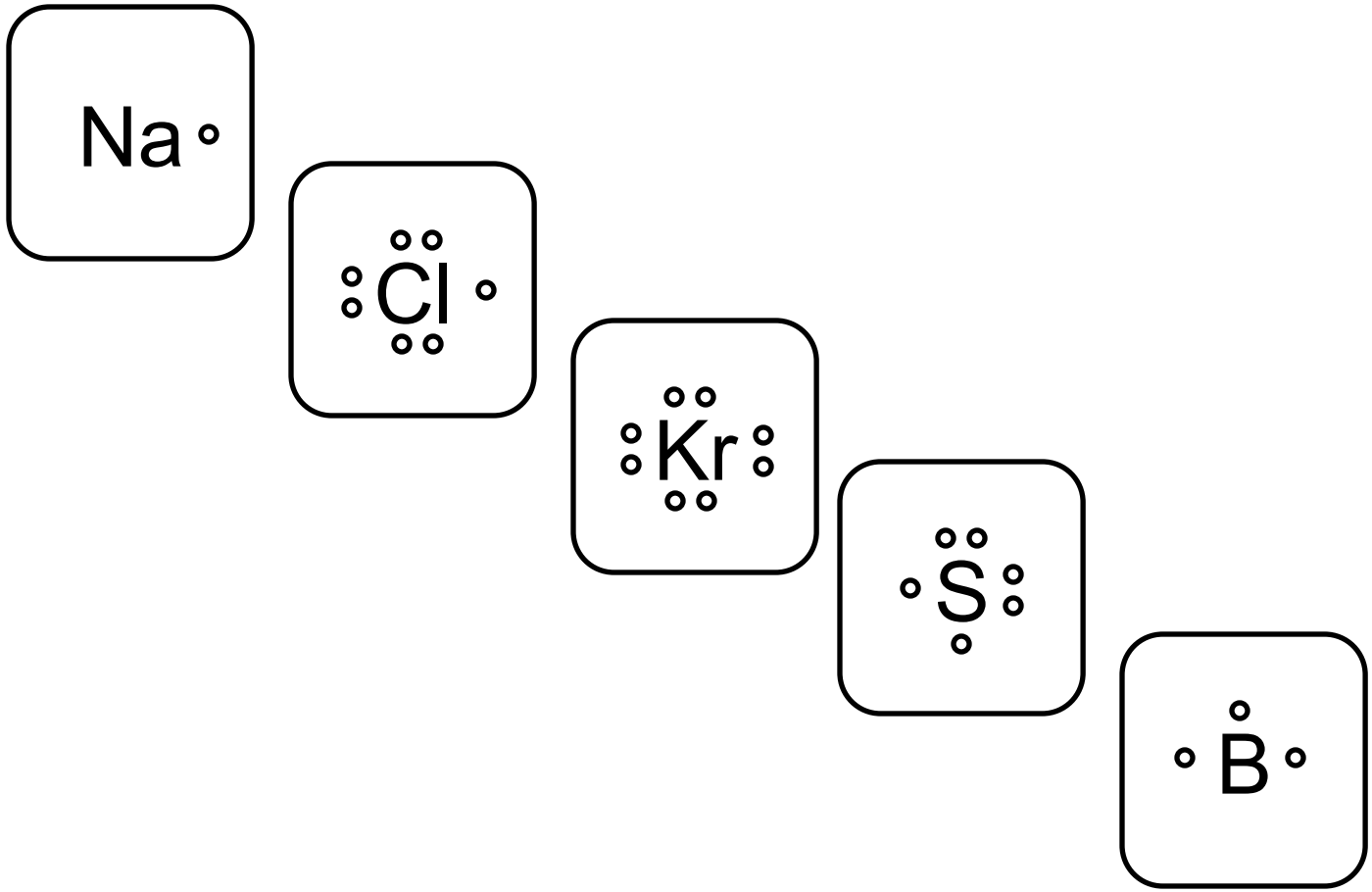
Na

Cl

Kr

S

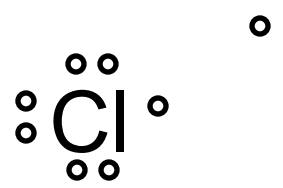
B



Valence Electrons and Chemical Bonds

- When an atom forms a chemical bond, one of two things happens:

  1. of eight.



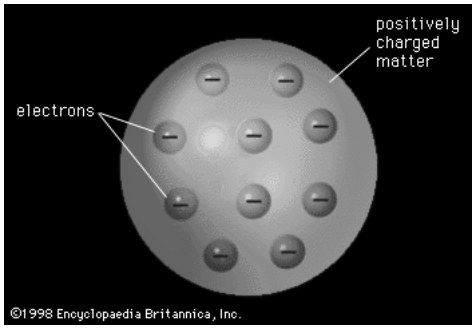
  2. All valence electrons are given up.

- When atoms have either 8 or 0 valence electrons, they are more stable, or less reactive.

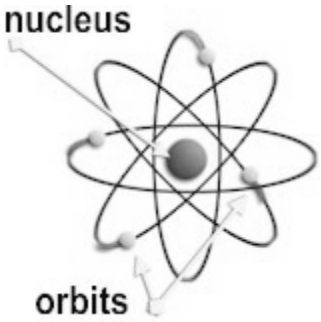
History of the Atomic Model

- Since John Dalton came up with his atomic theory, there have been many models of the atom.

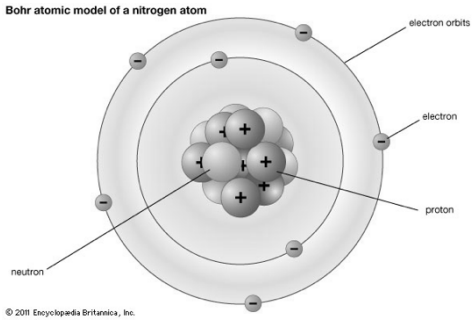
- Thomson Model (1897)



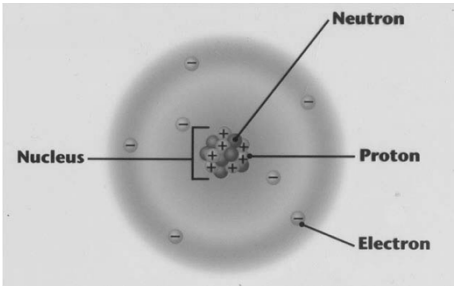
- Rutherford Model (1911)



- Bohr Model (1913)



- Modern Model



Section 2
Organizing the Elements

- Much in the way that a calendar arranges days, weeks, and months, the periodic table organizes the elements.

- By 1830, 55 elements had been discovered. This was before atomic numbers were discovered.

- Most of these were metals, a couple were gases, two were liquids, some reacted readily, and others did not.

- In the 1800s, it was thought that the elements should be organized into a system that applied to all elements.

Looking for Patterns in the Elements

- Scientists tried to look for patterns, but the ones that they found did not work for all elements.

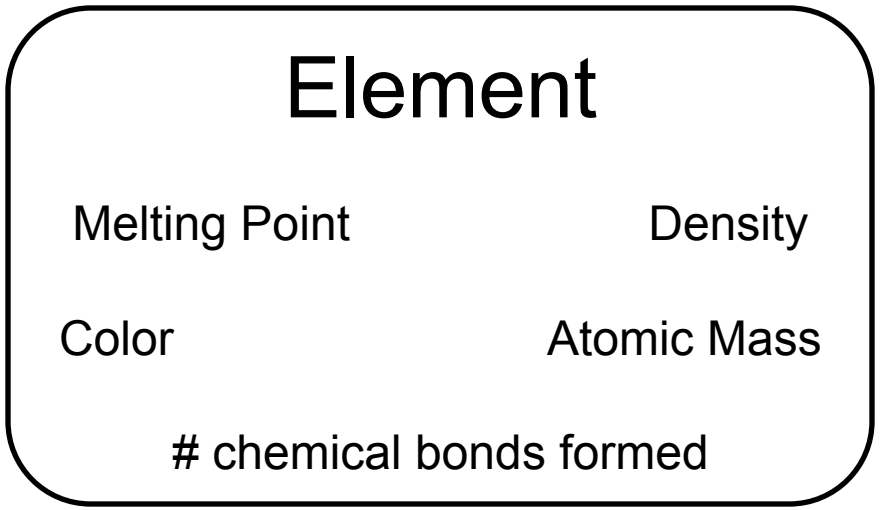
- By the 1860's, Dimitri Mendeleev discovered a system that applied to all the elements.

- He observed that elements have similar chemical and physical properties.

- Example – fluorine and chlorine are both gases that irritate your lungs if inhaled.

Looking for Patterns

- To help him organize the patterns, he wrote the elements on individual cards, including all of the properties he knew of those elements.



- These properties include melting point, density, and color.

- Two especially important properties that he included:
    1. atomic mass
    2. the number of chemical bonds an element could form.

Demonstration

- On the whiteboard, there are 16 cards. These cards each have a number and a shape written on them.

- Organize them to have a unique order that gives each card a unique position in the arrangement.

			
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4

Atomic Mass

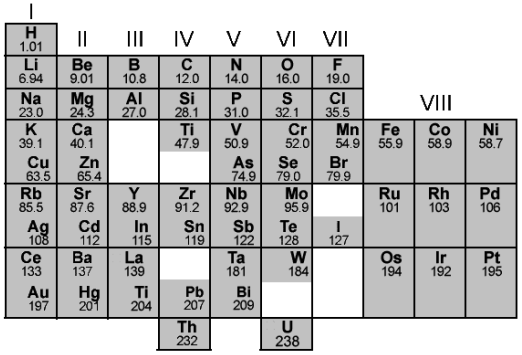
- **Definition:** Atomic Mass – the average mass of one atom of the element.
- In Mendeleev's day, the atomic masses were figured out by comparison to hydrogen, the lightest element.
- **Demonstration** – The masses of a group of objects are the following:

If the paperclips are analogous to the hydrogen atom, find a way to determine the mass of a single atom of each "element" in terms of "hydrogen."

"Elements"	Mass of Sample	Mass In terms of "H"
Paperclips	52.50g	1 paperclip
Pennies	129.50g	2.47 paperclips
Pens	260.00g	4.95 paperclips
Keys	320.00g	6.10 paperclips
Erasers	2529.00g	48.17 paperclips

The Periodic Table

- Mendeleev noticed that patterns appeared when the elements were arranged in order of increasing atomic mass.
- He placed the cards for the elements that bonded similarly together.
- Strictly using atomic mass did not always produce similar groups.

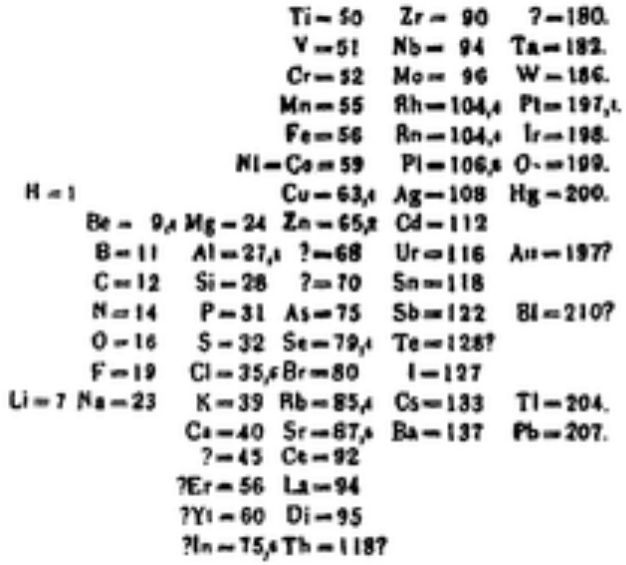


I	II	III	IV	V	VI	VII		VIII	
H 1.01									
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5			
K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 106
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
Au 197	Hg 201	Ti 204	Pb 207	Bi 209					
			Th 232		U 238				

- Mendeleev re-spaced the cards and noticed there were blanks.
- He was able to predict the elements that would fit in these spaces and their properties before they were even discovered!!

The First Periodic Table

- The first periodic table can be seen below:



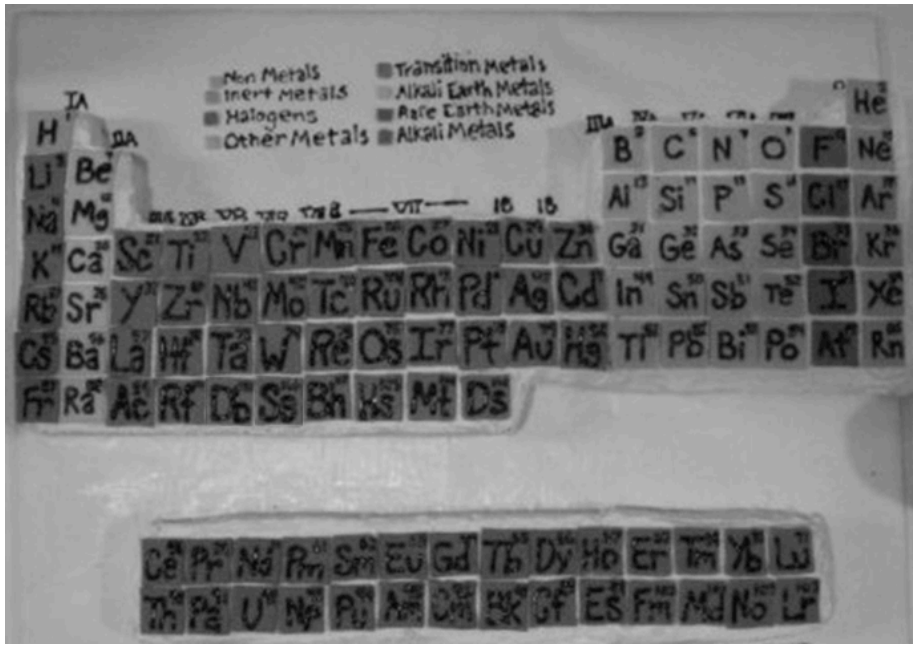
			Ti = 50	Zr = 90	? = 180.
			V = 51	Nb = 94	Ta = 182.
			Cr = 52	Mo = 96	W = 186.
			Mn = 55	Rh = 104,4	Pt = 197,1.
			Fe = 56	Ru = 104,4	Ir = 198.
			Ni = Co = 59	Pl = 106,6	Os = 199.
H = 1			Cu = 63,4	Ag = 108	Hg = 200.
	Be = 9,4	Mg = 24	Zn = 65,2	Cd = 112	
	B = 11	Al = 27,4	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?
	O = 16	S = 32	Se = 79,4	Te = 128?	
	F = 19	Cl = 35,6	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204.
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207.
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75,6	Th = 118?		

- It was published in 1869. Within 16 years, the three missing elements were discovered, and were found to have properties similar to those that were predicted.

The Modern Periodic Table

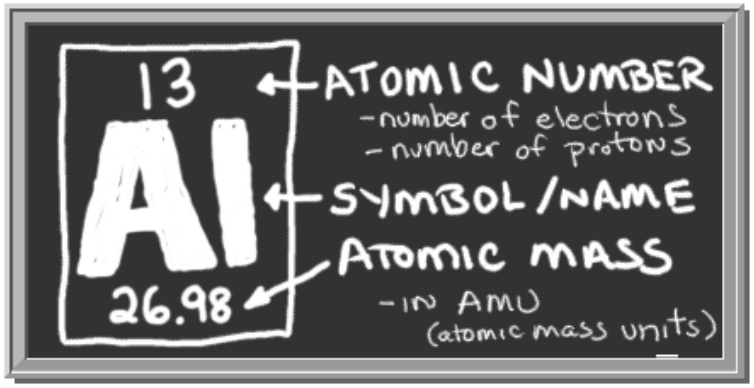
- Periodic means “a regular, repeated pattern.”

- The *modern* periodic table has properties repeating in each period (row) of the table.



Reading the Periodic Table

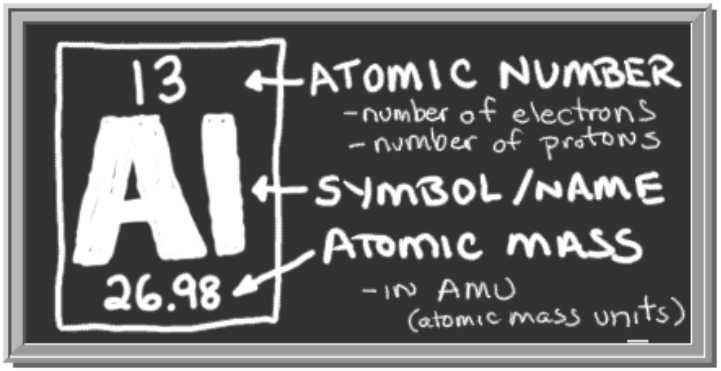
- Each square of the periodic table usually includes the element's atomic number, chemical symbol, name, and atomic mass.



- The atomic number tells you how many protons and electrons each neutral atom of that element has.

- Most element symbols contain one or two letters. The first is always capitalized, and the second is always lower case.

Inside the Squares

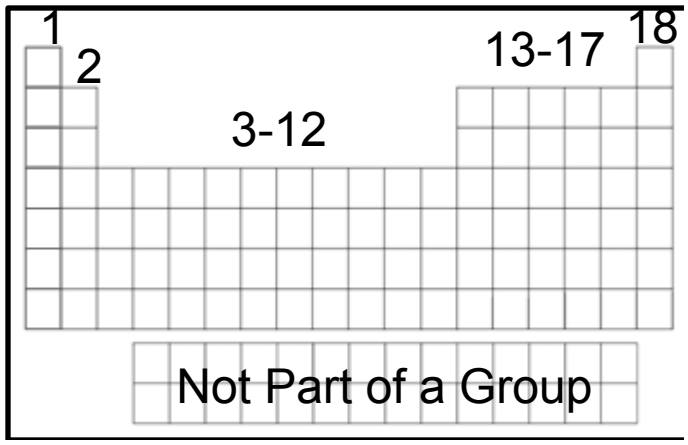


- The atomic mass of the element is also found in the square. This is the average mass of an element's atoms.

- This means that the average of the mass of each isotope of the element is averaged together in their corresponding proportions (weighted average).

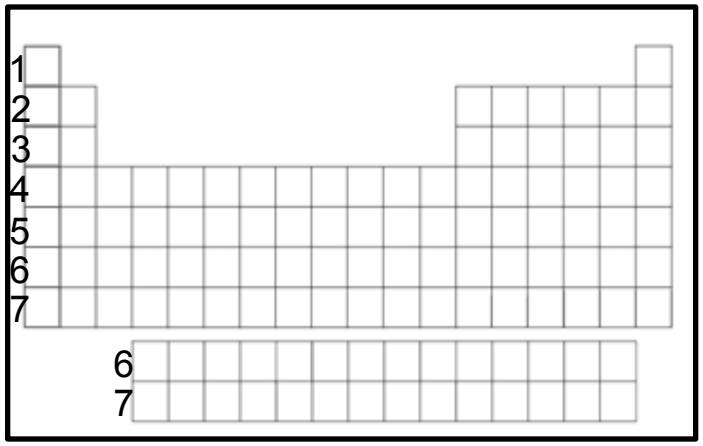
Organization of the Periodic Table

- The periodic table is arranged by atomic number from left to right.
- An element's properties can be predicted from its location in the periodic table.
- **Definition:** Group – the columns of the periodic table, also known as families.
- Groups are numbered 1-18. Sometimes, a group may have it's own name, like the halogens in group 17.
- The elements in each group or family may have similar properties/ characteristics.



Organization of the Periodic Table

- **Definition:** Period – the rows of the periodic table.



- A period contains different types of elements from different families.
- Elements in a period have very different properties.
- A period typically has metals, metalloids, and nonmetals with in it.

Why the Periodic Table Works

- The periodic table works because it's based on the structure of the atoms, especially the valence electrons.

- The elements in a family have the same number of valence electrons.

- Recall: The number of valence electrons an element has is equal to the ones place of it's group number.

- In which family do the elements have 3 valence electrons? 7 valence electrons?

Section 3
Metals

- Metals exist everywhere: in your computers, your pens, your food, and even your blood.

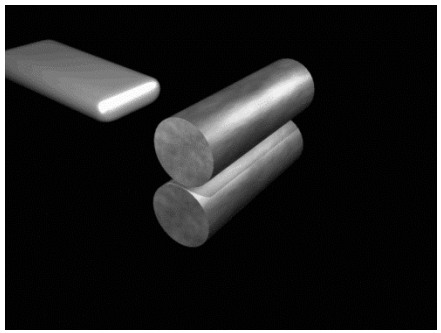


- But what is a metal? What kinds of properties do metals have?

- Chemists classify an element as a metal based on physical properties such as hardness, shininess, malleability, and ductility.

Physical Properties

- A malleable material is one that can be pounded into shapes.

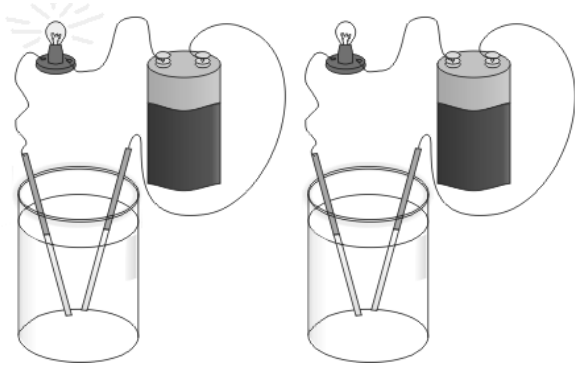


- A ductile material is one that can be pulled out, or drawn, into a long wire. Copper is a very ductile and malleable metal.

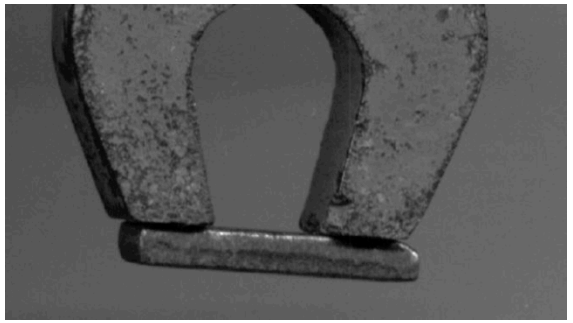
- Luster is shininess. A good example of this is polished silver (Ag).

Metal Physical Properties

- Most metals are good conductors because they transmit heat and electricity easily.



- Several metals are magnetic ; they are attracted to magnets and can be made into magnets.



- Most metals are solids at room temperatures. In fact, you would need to raise the temperatures of some metals as high as 3400°C to melt them.

Chemical Properties

- Metals show a wide range of chemical properties.

- Some metals are very reactive. Metals such as sodium (Na) are so reactive that to prevent explosive reactions with the air, they must be stored under oil in sealed containers.

- Other metals are not very reactive at all. For example, gold (Au) and chromium (Cr).

Chemical Properties

- A metal can wear away as the soft metal oxide flakes off. This process of reaction and wearing away is called corrosion.

- Rusting iron is an example of corrosion.

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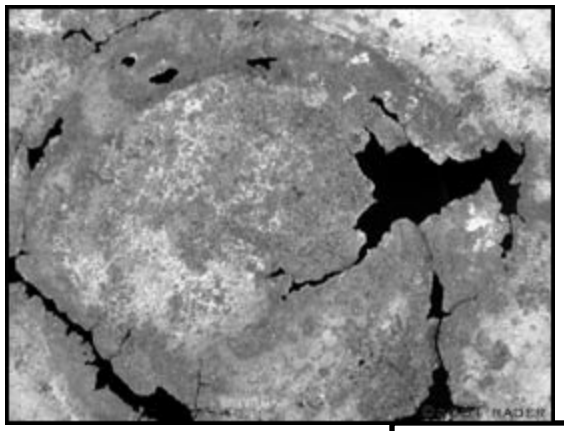


Sharpen Your Skills

- Let's examine a difference in the properties between zinc and copper.

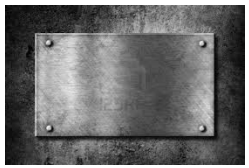
- Both zinc and copper are transition metals. After 1983, they are both found in pennies.
- Take 1 penny per group, 1 cup, and 1 strip of sandpaper.
- Sand the penny on the same spot at least 10 times, until the zinc is showing.
- Put the penny in the cup with vinegar. We are going to let these stand for a few days, so write your name on the cup in sharpie.

Alloys

- If you recall, mixtures consist of two or more substances mixed together but not chemically changed.

- Do metals form useful mixtures? What might some of them be?

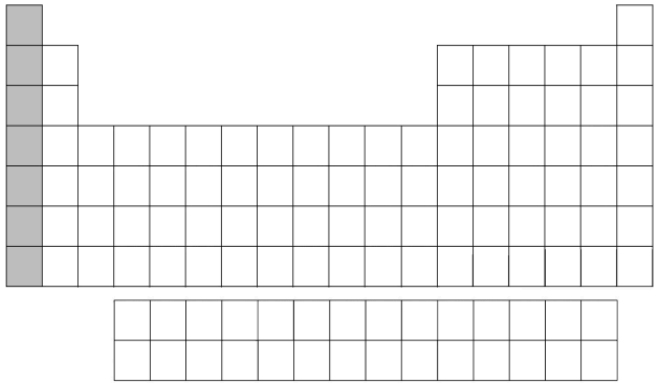
- Steel – mixture of iron, carbon, chromium, and vanadium
- Bronze – mixture of copper and tin
- Brass – mixture of copper and zinc



- The metals in a group, or family, have similar properties, and these family properties change gradually as you move across the table.

Alkali Metals

- **Definition:** Alkali Metals – metals in Group 1, from Lithium to Francium.



- These are the most reactive metals of all. They are never found uncombined in nature.

- Alkali metals have only 1 valence electron. Since atoms are most stable with 0 or 8 electrons, the metals are willing to give up their 1 readily.

Alkali Metals

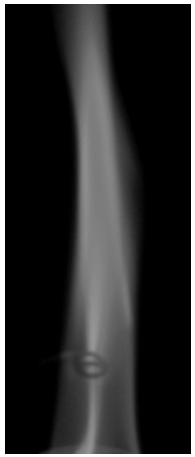
- Sodium and potassium are two of the most important alkali metals.
- Sodium is found in large amounts in sea water and salt beds.
- Humans need both sodium and potassium to survive. They are found in many of our foods.
- Lithium can be used in batteries and certain drugs.

Demonstration

- Scientists can determine whether compounds contain certain elements, such as alkali metals, by performing a flame test, because these metals produce distinctive colors.

- Observe the colors of the flames from the different metals used.

- What do you notice?



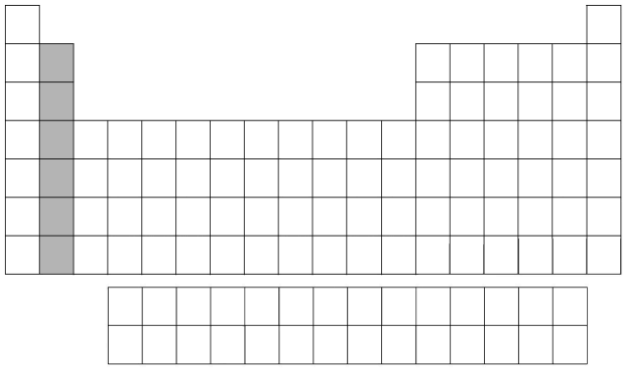
Lithium

Sodium

Potassium

Alkaline Earth Metals

- **Definition:** Alkaline Earth Metals – metals from Group 2 in the periodic table from Beryllium to Radium

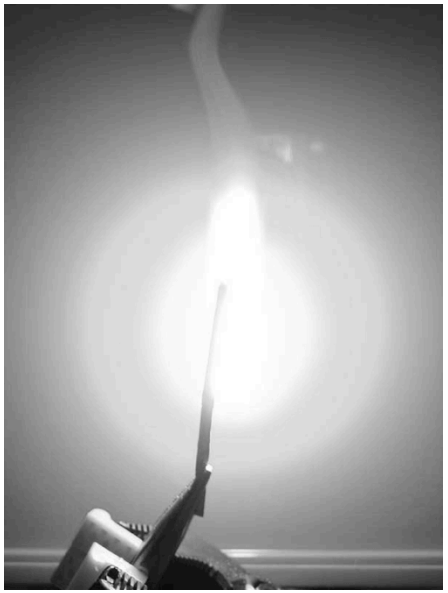


- These are not as reactive as the alkali metals, but still are more reactive than most.

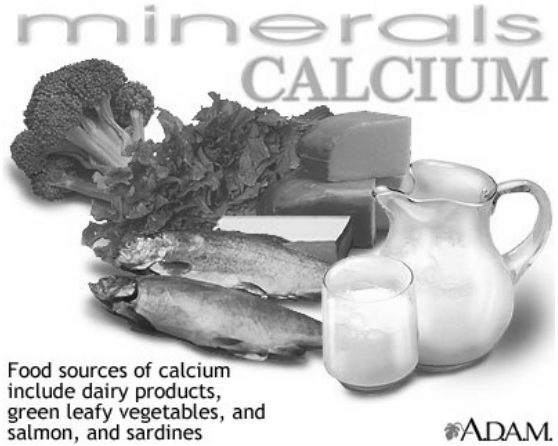
- Each alkaline earth metal is *almost* as reactive as it's neighbor to the left.

- The two most common alkaline earth metals are magnesium and calcium.

Magnesium and Calcium



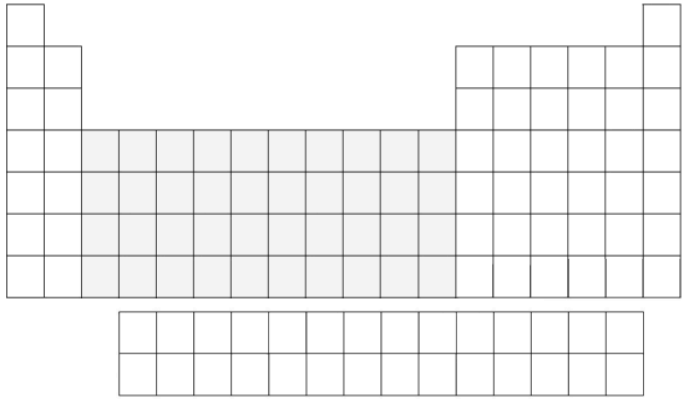
- Magnesium used to be used for light bulbs, and can make a light weight alloy with aluminum.



- Calcium makes up an essential part of bones and teeth. It is also found in sea shells, milk, and leaves.

Transition Metals

- **Definition:** Transition Metals – the metals in Groups 3 through 12.

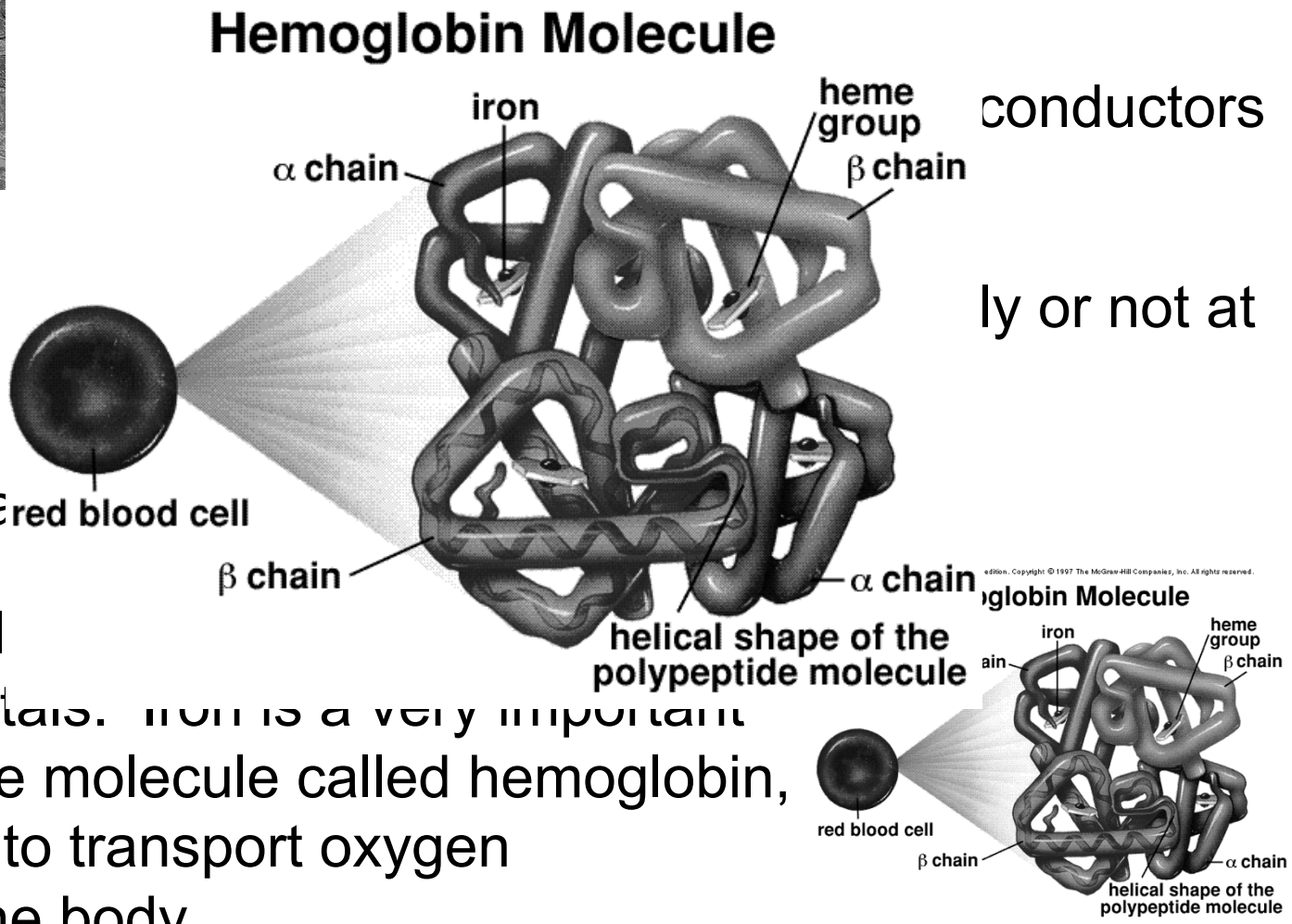


- These form a bridge between the very reactive metals on the left side of the periodic table and the less reactive metals on the right side of the periodic table.

- Most of the familiar metals, including copper, zinc, gold, silver, iron and nickel are transition metals.

Properties of Transition Metals

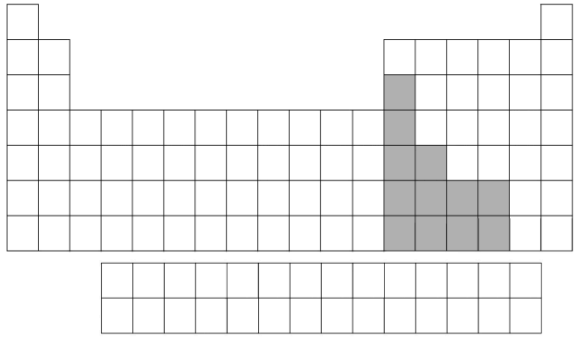
- Transition metals tend to be hard and shiny. Some even have unusual colors, such as copper and gold.



- They tend to conductors
- They tend to ly or not at all with air.
- Some are ma
- Humans coul
transition metals. Iron is a very important part of a large molecule called hemoglobin, which helps to transport oxygen throughout the body.

Metals in Mixed Groups

- Groups 13 through 16 of the periodic table include metals, nonmetals and metalloids.



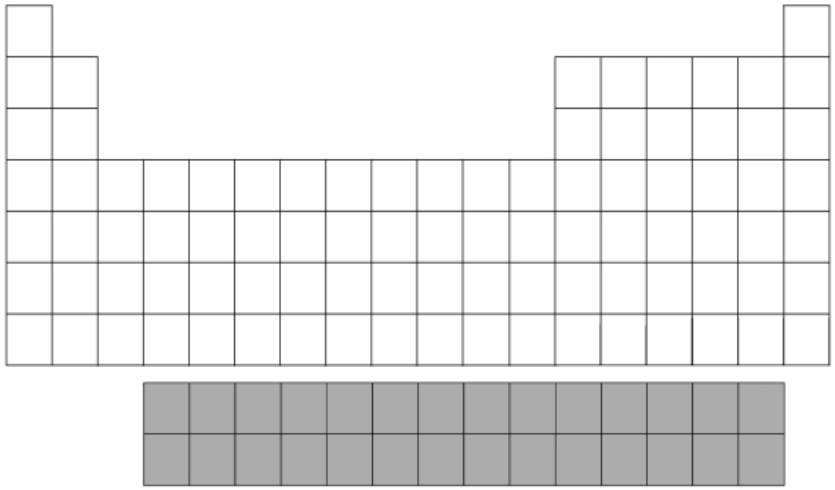
- These metals are not nearly as reactive as those on the left side of the table.
- The properties, and uses, of these metals vary greatly.
- Aluminum – used in beverage cans and airplane bodies
- Tin – used to coat steel cans to prevent corrosion
- Lead – used in car batteries (used to be used for paints and water pipes).

Lanthanides and Actinides

- **Definition:** Lanthanides – the top row of the two at the bottom of the periodic table.

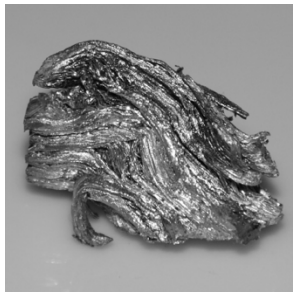
- **Definition:** Actinides – the bottom row of the two at the bottom of the periodic table.

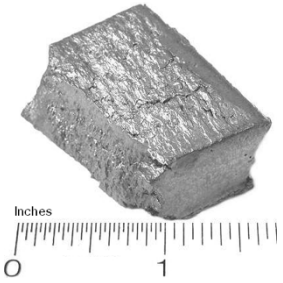
- These are called the rare earth elements.



Properties of Rare Earth Metals

- Lanthanides are
  - Soft
  - Malleable
  - Shiny
  - Highly conductive
  - Used to make various alloys
  - Difficult to separate from one another





- Of the actinides, only thorium (Th) and uranium (U) exist in any sufficient amounts on Earth.
- All actinides after uranium are synthetic.

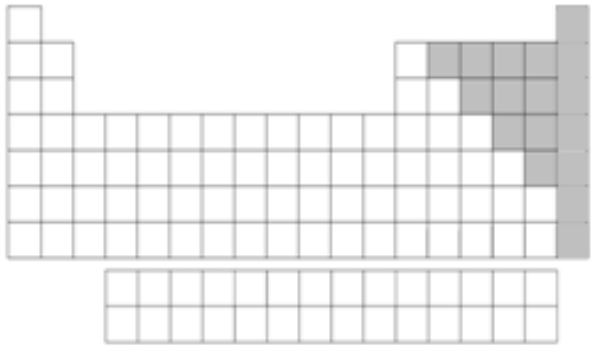
- Some only last for fractions of a second after being made.

Section 4
Nonmetals and Metalloids

- The properties of nonmetals vary from soft and smooth to hard and rough.

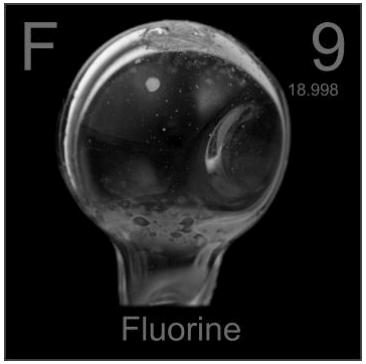
- There are lots of materials that contain little to no metal.

- **Definition:** Nonmetals – elements that lack most of the properties of metals.



- There are 17 nonmetals, each located to the right of the zigzag line in the periodic table.

Physical Properties of Nonmetals



- Many nonmetals are gases at room temperature, such as oxygen(O), fluorine (F) and nitrogen (N).
- They therefore have low boiling points.
- Most of the rest are solids at room temperature, such as carbon (C), sulfur (S), and iodine (I).
- Bromine (Br) is the only nonmetal that is a liquid at room temperature.

Physical Properties of Nonmetals

- In general, physical properties of nonmetals are opposite those of metals.

  - Most are dull.

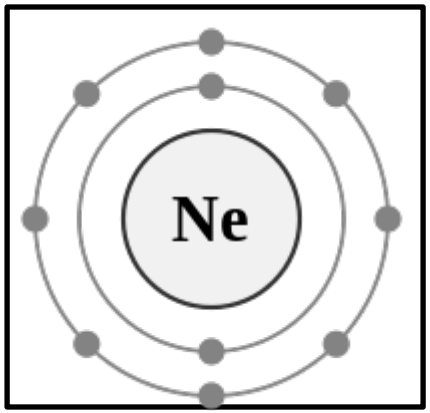
  - Solid nonmetals are brittle (not malleable or ductile). They break easily when struck with a hammer.

  - Have lower densities than metals.

  - Poor conductors of heat and electricity.

Chemical Properties of Nonmetals

- Most nonmetals readily form compounds.
- Group 18 hardly ever reacts with anything. This has to do with the fact that group 18 elements naturally have 8 valence electrons.

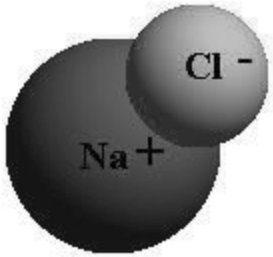


- The rest of the nonmetals have atoms that can gain or share electrons.

Compounds of Nonmetals

- When nonmetals and metals react, valence electrons move from the metal atoms to the nonmetal atoms.

- Ex – Table salt (NaCl) is formed from sodium (a very reactive alkali metal) and chlorine (a very reactive halogen nonmetal).



Salt

- Other groups may react as well. For example, iron and oxygen can form rust (Fe_2O_3).

Compounds of Nonmetals

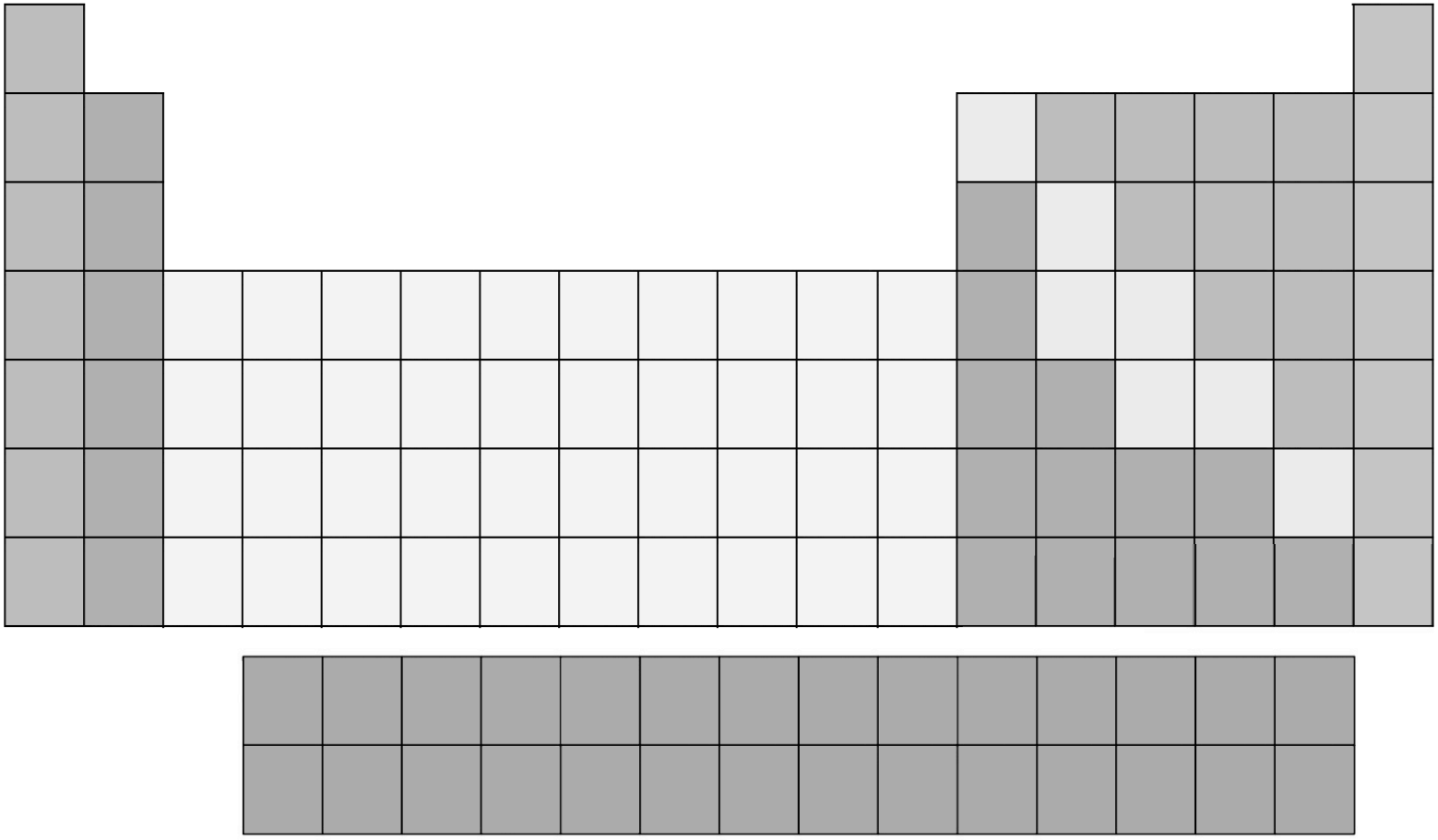
- Nonmetals can also react with other nonmetals.
- In this case, instead of a transfer of electrons, we see that the valence electrons are shared.
- Examples of such a compound include carbon dioxide (CO_2) and carbon monoxide (CO).
- **Definition:** diatomic molecules – molecules containing only two atoms.

Diatomic Molecules

- Some nonmetals elements form diatomic molecules, as well.
- There are seven diatomic elements.
- These include oxygen (O_2), nitrogen (N_2), hydrogen(H_2), and several others.
- Many, but not all, of the diatomic molecules are gases.

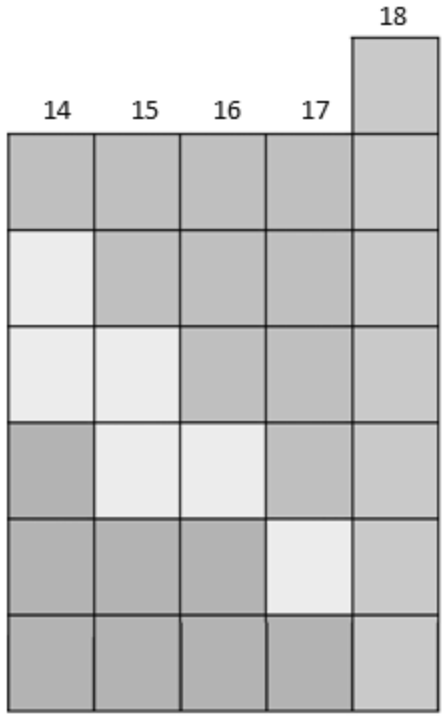
A Color-Coded View of the Periodic Table

- Color code your periodic table in the packet. Include a key.

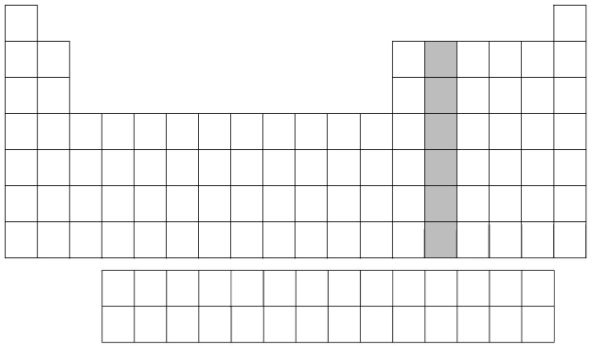


Families of Nonmetals

- Only Group 18 contains nonmetals exclusively.
- Groups 14 and 15 contain three classes of elements: nonmetals, metalloids, and metals.
- Therefore, groups 14 and 15 may not be as similar in chemical properties as other groups.
- With more nonmetals in each group, elements in 16 and 17 are more similar in character than groups 14 and 15.



The Carbon Family



- Group 14 is known as the carbon family.

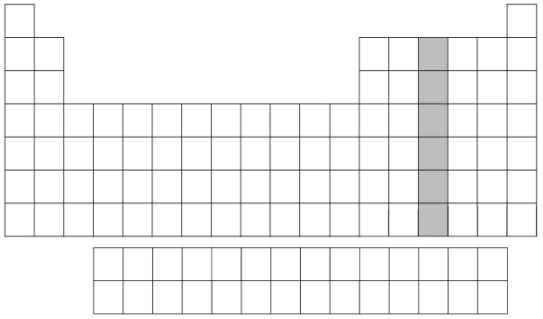
- These elements have 4 valence electrons.

- Only one of these elements is a nonmetal (carbon, C).

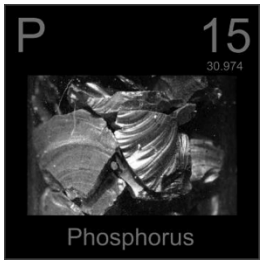
- Carbon plays a strong roll in the chemistry of life.

- There are millions of molecule types containing long carbon chains, sometimes having billions of atoms.

The Nitrogen Family

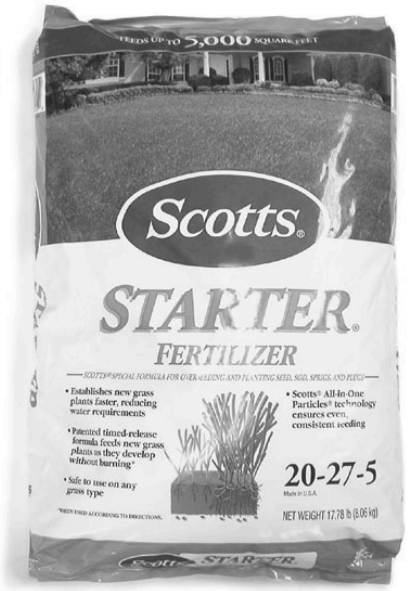


- Group 15 is known as the nitrogen family.
- These elements have 5 valence electrons.
- There are two nonmetals in this family: nitrogen (N) and phosphorus (P).



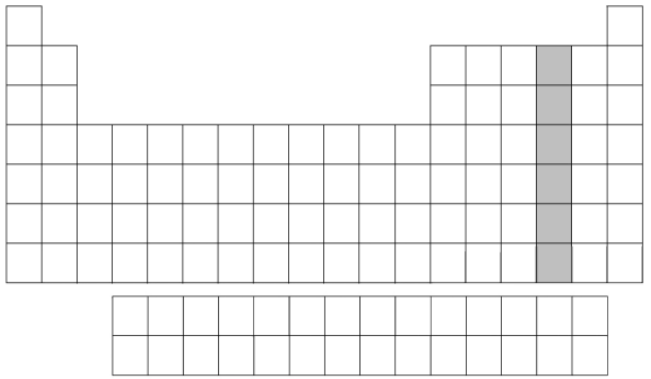
- Nitrogen makes up 80% of our atmosphere.
- N_2 gas does not react readily with other elements, so you breathe out as much as you breathe in.

The Nitrogen Family



- Only certain kinds of bacteria are able to combine nitrogen gas with other elements.
- Nitrogen compounds produced by these bacteria are taken in by plants for nutrients.
- Fertilizers tend to have a decent concentration of nitrogen.
- Phosphorus is able to react with other elements readily.
- It may be used to make matches and flares.

The Oxygen Family



- Group 16 is called the oxygen family.
- These elements have 6 valence electrons.
- These atoms typically gain or share 2 electrons when they react.
- There are three nonmetals in this group: oxygen (O), sulfur (S), and selenium (Se).

- Selenium is a rarer element than either oxygen or sulfur.

The Oxygen Family

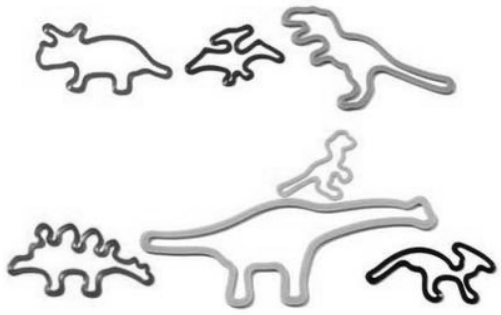
- Humans breathe oxygen gas (O_2) to survive.
- Sometimes, however, oxygen can form a triatomic molecule (3 atoms) called ozone (O_3).
- Ozone helps to screen out harmful radiation from the sun.
- Oxygen is very reactive, and can combine with almost anything.

The Oxygen Family

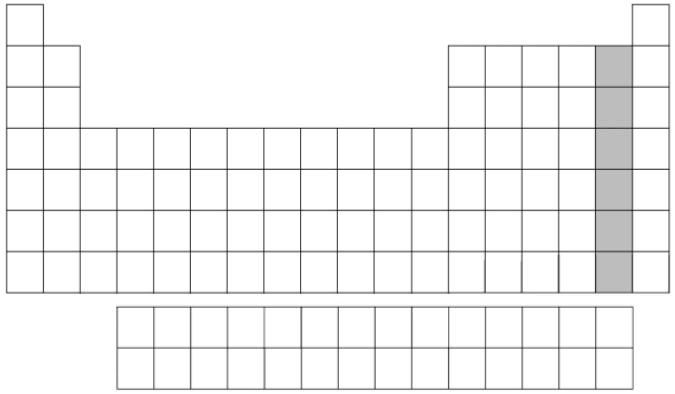
- Oxygen is the most abundant element in Earth's crust, and the second most abundant in the atmosphere.

- Sulfur is very common as well. It smells like rotten eggs.

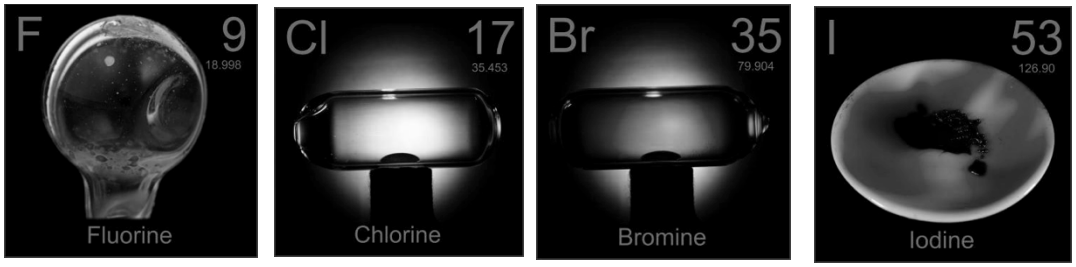
- Sulfur also exists in rubber bands, car tires, and many medicines.



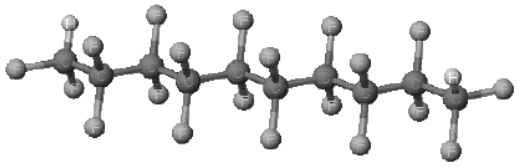
Halogens



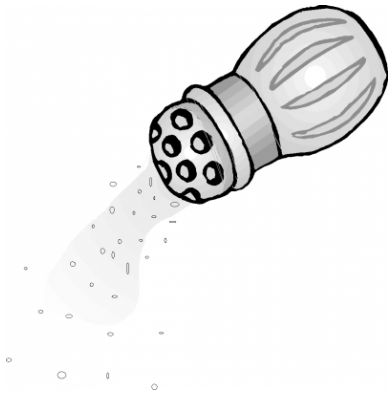
- Group 17 is called the halogen family.
- Halogens have 7 valence electrons.
- Therefore, when bonding, halogens tend to gain or share an electron.
- All but one of the halogens are nonmetals, but all share similar properties.
- The nonmetal halogens include:



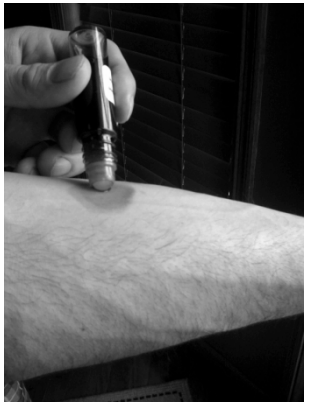
Halogens



Teflon, $-(CF_2CF_2)-$

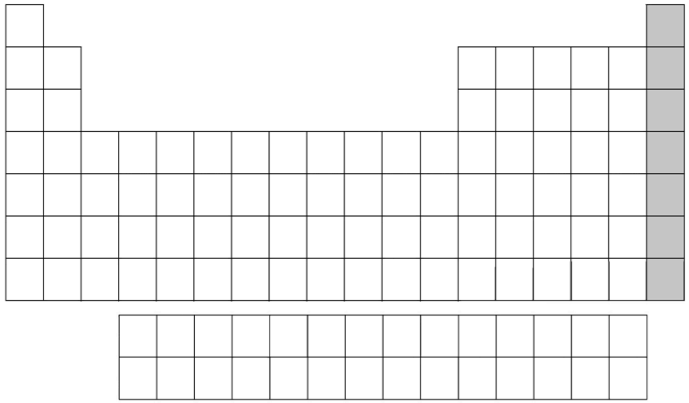


- Halogens are VERY reactive nonmetals.
- Most pure halogens are dangerous to humans.
- Compounds formed with halogens may be useful, such as table salt (sodium chloride, NaCl), teflon, and silver bromide (AgBr).



Noble Gases

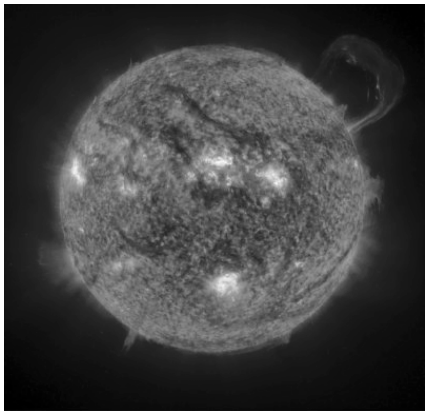
- Group 18 elements are called noble gases.



- The term comes from “noble” individuals, who do not mix with “ordinary” people. The noble gases do not typically form compounds with other elements.

- Therefore, they are chemically stable and unreactive.

Noble Gases



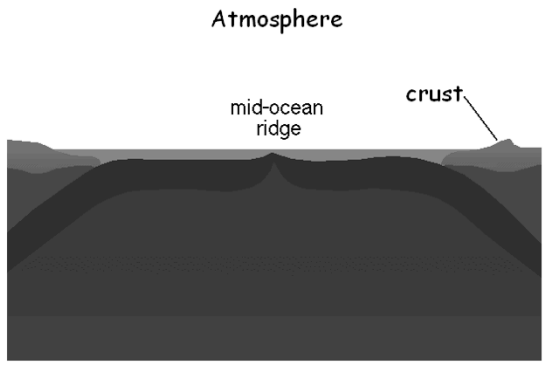
- All noble gases exist on Earth, but in small amounts.
- Due to their stability, they were not discovered until the late 1800s.
- Helium was discovered by a scientist studying the sun.
- Noble gases are used for a variety of things, including filling balloons, and in neon lights (“neon” is usually a misnomer).

Hydrogen

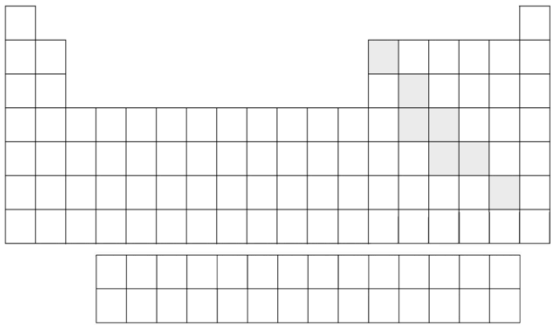
- Hydrogen is the simplest element. It usually only has one proton and one electron.

- It is typically not able to be grouped into a family.

- Hydrogen makes up 90% of the atoms in the universe, but only 1.0% of the mass of Earth's crust, oceans, and atmosphere.



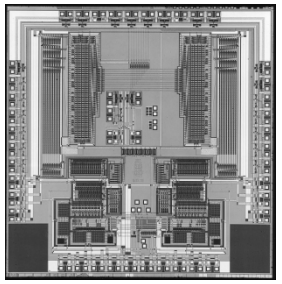
- It is rarely found on Earth in its elemental form.



The Metalloids

- **Definition:** Metalloids – seven elements on the border between the metals and the nonmetals.

- These have some characteristics of metals and some of nonmetals.



- The most common metalloid is silicon (Si).

- The most useful property of the metalloids is their varying ability to conduct electricity.

- **Definition:** Semiconductors – substances that may or may not conduct electricity based on environment.

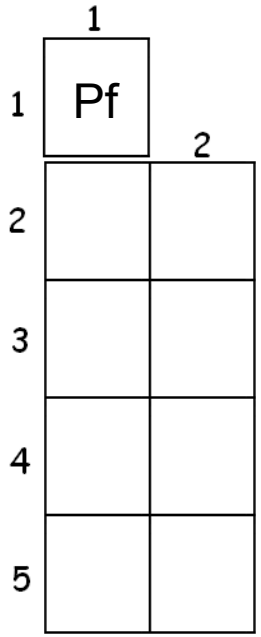
Skills Lab – Alien Periodic Table
p. 104-105

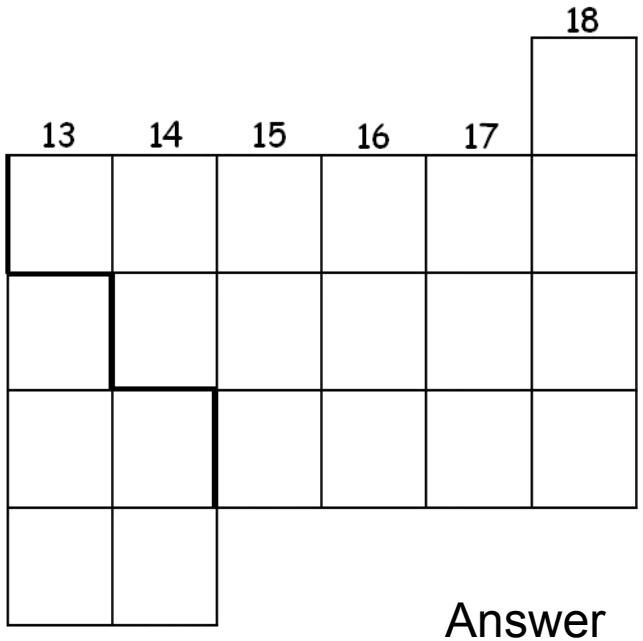
- Read each of the clues given to you in step 2 of the procedure before beginning the lab.
- Using this information, fill in the blank periodic table provided.
- Answer the Analyze and Conclude questions 1-5. Type your answers.
- More to Explore should be completed as well.

Alien Periodic Table

- For example, the 5th clue says that the lightest element is called pfsst (Pf).

- Since the lightest element is Hydrogen, I will put the symbol for pfsst in the place of hydrogen.





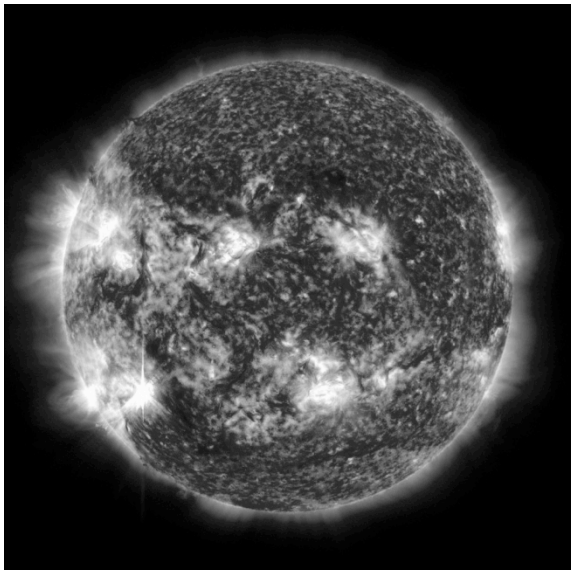
Answer

Section 5
Elements From Stardust

- Scientists have looked to the stars to attempt to figure out where the elements come from and why some are more common than others.

- The sun is a star, and like other stars, it is mostly made of hydrogen.

- This hydrogen exists at approximately 15 million degrees Celsius.

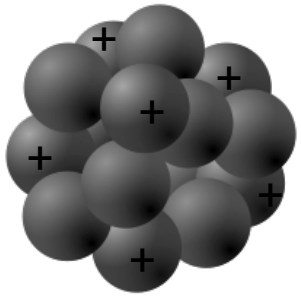


Atomic Nuclei Collide

- At the high pressures and hot temperatures found inside the sun and other stars, hydrogen exists in the fourth state of matter.

- **Definition:** Plasma – a high-temperature physical state of matter wherein atoms are stripped of their electrons, and the nuclei are packed close together.

- Nuclei are positively charged, so normally, they would repel each other.

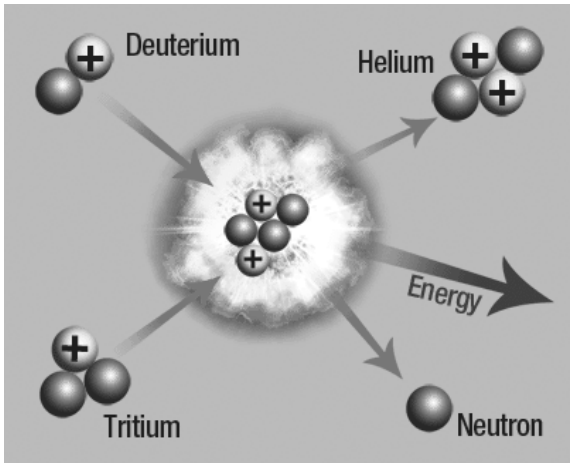


Atomic Nuclei Combine

- However, inside stars, the nuclei are extremely close and moving very fast, fast enough to collide with one another.

- Sometimes, the collisions are big enough for them to join together.

- **Definition:** Nuclear Fusion – atomic nuclei combine to form a larger nucleus, releasing huge amounts of energy in the process.



Elements from the Sun

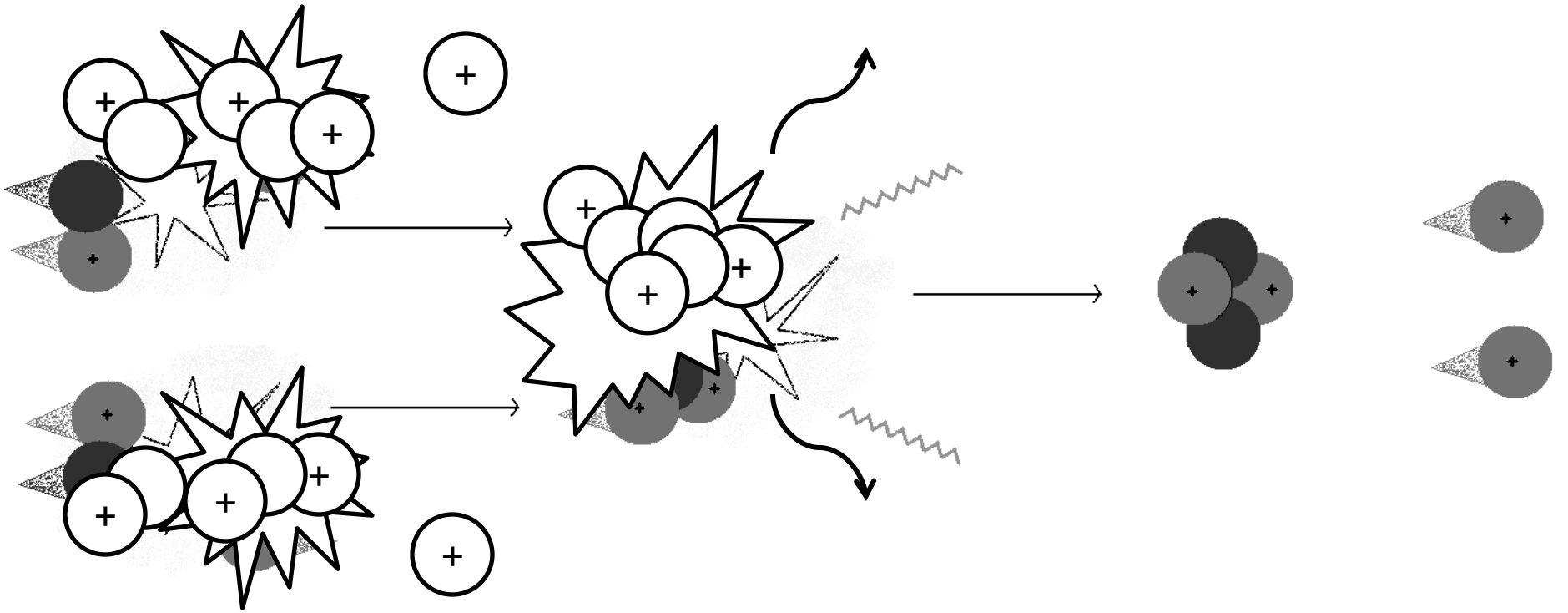
- Inside stars, nuclear fusion combines smaller nuclei into larger nuclei, thus creating heavier elements.

- Think of stars as “element factories.”

- Remember that most hydrogen nuclei are just a single proton, but some include one or two neutrons.

- Inside the sun, helium nuclei are produced through nuclear fusion.

Elements From the Sun



Hydrogen nuclei (with and without neutrons)

Helium nuclei (one neutron each)

Helium nucleus

Hydrogen nuclei

- Notice that the reaction requires a type of hydrogen nuclei that contains neutrons.

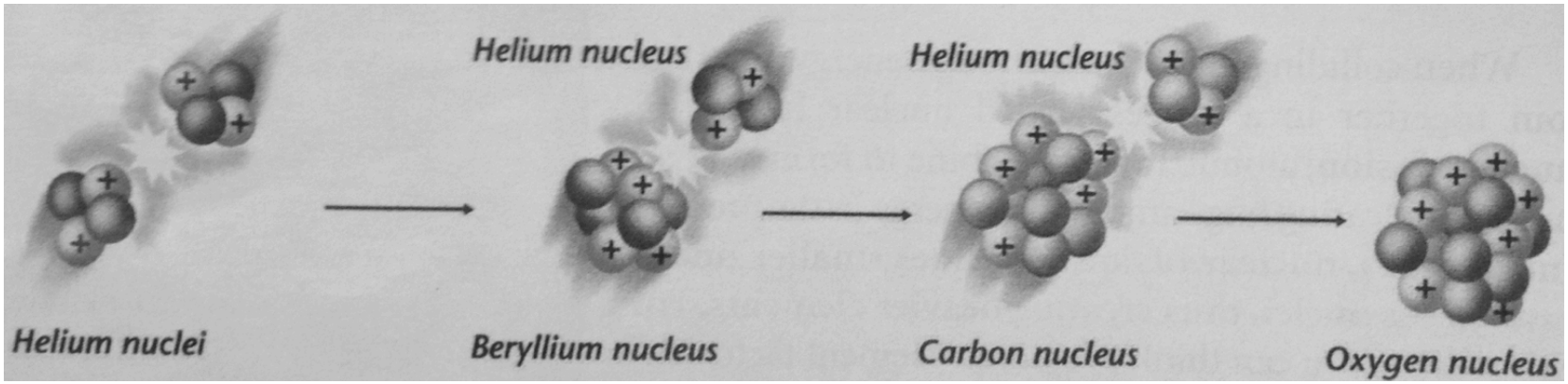
Elements From the Sun

- Hydrogen is the fuel that powers the sun.
- Scientists estimate that the sun won't run out of hydrogen for approximately another 5 billion years.
- The sun's temperature and volume change with the amount of helium in the core.
- These changes allow for different fusion reactions to occur.

Elements From the Sun

- Two helium nuclei may come together to form a beryllium nucleus.

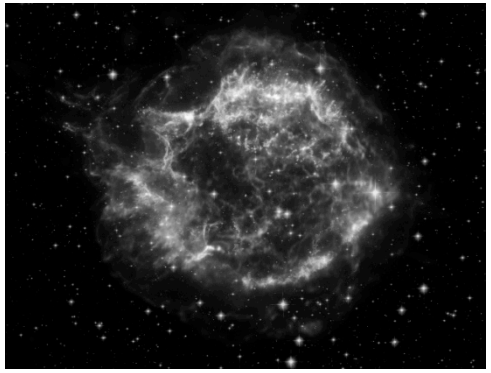
- Adding another helium nucleus may yield carbon, and then another will yield oxygen.



- Stars the size of the sun do not contain enough energy to produce elements heavier than oxygen.

Elements From Large Stars

- Larger stars become hotter than the sun as they age.
- Therefore, they have enough energy to produce heavier elements than oxygen, such as iron and silicon.
- The core of more massive stars is usually made mostly of iron.
- **Definition:** Supernova – a tremendous explosion that breaks apart a massive star, producing temperatures up to one billion degrees Celsius.



Elements from Large Stars

- The matter in the sun, and the planets around it, originally came from a gigantic supernova that occurred billions of years ago.

- This includes Earth.

- This means that everything all around you is made of stardust.