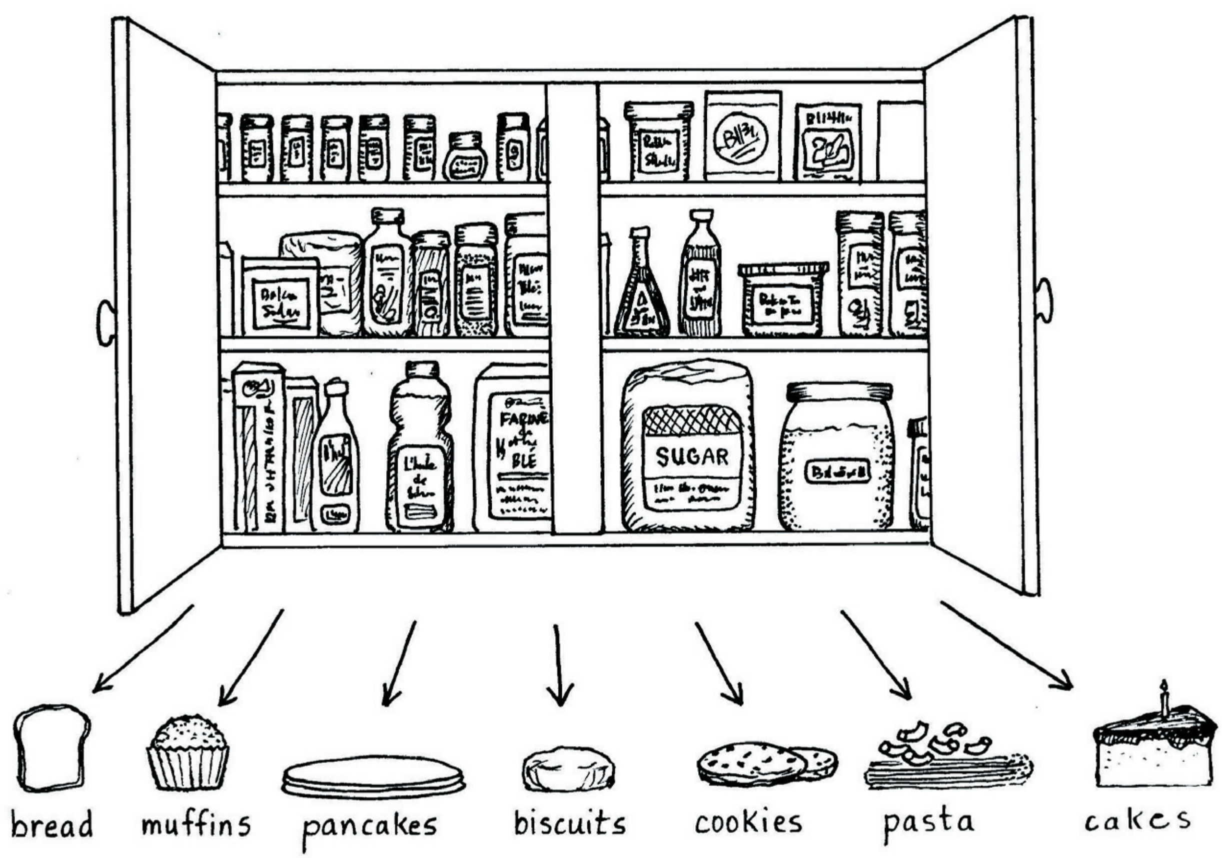
CHAPTER 1: WHAT IS AN ELEMENT?

Do you ever help bake things like cookies, cakes, biscuits, or bread? If so, you may have noticed that all baked goods are made from basically the same ingredients: flour, sugar, salt, eggs, butter, vegetable oil, baking powder, yeast and flavorings. All baked goods are made of basically the same ingredients, yet you have no problem telling the difference in taste and texture between pancakes and donuts, or biscuits and bread.

Even though they contain many of the same ingredients, the ingredients are used in different proportions. Cookies, for example, have lots of butter and sugar and not too much flour. Biscuits have less sugar than cookies do, and contain no eggs. Bread is mostly flour, with only a small amount of sugar and butter (and some yeast to make it rise). The same ingredients in your kitchen can be used in many different ways to make many different foods.



So, all of these foods can be made from the ingredients in your cupboard. The reason they are different is that they have more of some things and less of others. Just a pinch of flavoring or spice can change one recipe into another.

Activity #1

Use a cookbook to find the information for this activity (or ask an adult who knows a lot about cooking). For each baked good, put check marks in the boxes, showing what ingredients it contains. You are free to choose any recipes you like.

	flour	sugar	eggs	oil or butter	milk or water	yeast	baking powder	vanilla	banana	chocolate or other flavor
BREAD										
COOKIES										
BISCUITS										
PANCAKES										
CAKE										
BANANA MUFFINS										

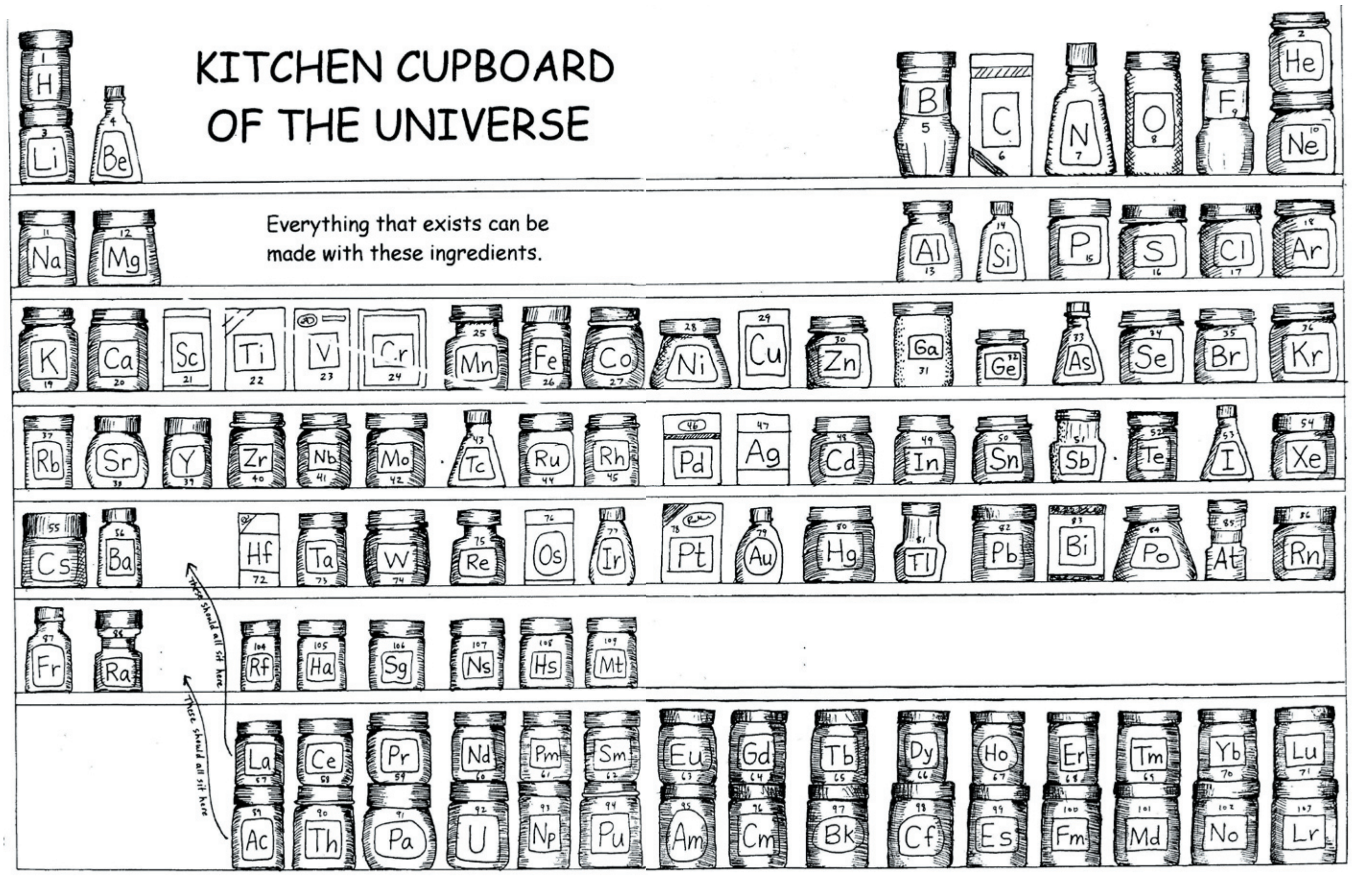
Name an ingredient that is found in all of the baked goods:______________
Name an ingredient that is found in most of the baked goods: _______________
Name an ingredient that is found in only one of the baked goods: _____________

Activity #2

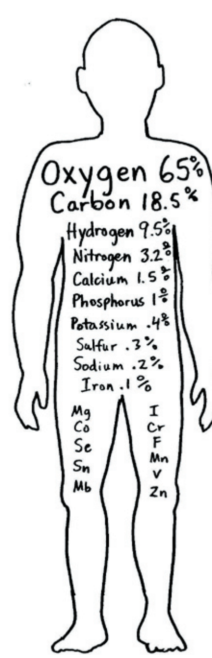
Think about cookies (tough assignment, eh?) and answer these questions:

1) How would a cookie change if you put it in the freezer?
2) How would a cookie change if you let it sit out somewhere for a week?
3) How would a cookie change if you put it in a glass of water?
4) Do these changes mean that the recipe changed?
5) Do other factors, not just the recipes, contribute to the quality of foods?

So baked goods are made of ingredients. But what are these ingredients made of? What is flour made of? What is water? What is oil? These baking ingredients are made of chemical ingredients called **elements**. The chemical elements are the most basic ingredients of all. They are the things that everything else is made of. There are 109 of these elements, and if we could put a sample of each into a little bottle or box, we'd have sort of a "kitchen cupboard of the universe."



These are the ingredients that make up anything you can think of: plants, animals, rocks, plastic, metal, fuel, fabric, computers, food, water, air, garbage... anything!. Your body is made of these elements, too. You are a "recipe" of these chemical ingredients.



Some of these chemical elements are very common and are found in practically everything, just like flour is found in so many baked goods. You may already be familiar with the names of some of these common elements: hydrogen, carbon, nitrogen, oxygen and silicon. These five elements account for most of the matter in the universe! Other elements are less common and have names you've never heard of, such as osmium or ruthenium. These uncommon elements are a bit like the spices lurking at the back of your cupboard-- the ones you use only once in a while, such as dill weed or coriander.

Isn't it great to find out that you already know some of these elements? You've known about helium since you were old enough to hold a balloon. You just didn't know it was one of the 109 basic ingredients of the universe. You know quite a few more, too, like gold, silver, lead, iron, copper, nickel, and aluminum. How many others do you know?

Activity #3

How many of these elements do you recognize? Circle any name that you have heard of, even if you don't know exactly what it is. (This is not a complete list of all 109.)

hydrogen	helium	lithium	boron	carbon
nitrogen	oxygen	fluorine	neon	sodium
magnesium	aluminum	silicon	phosphorus	sulfur
chlorine	potassium	calcium	magnesium	titanium
chromium	iron	cobalt	nickel	copper
zinc	lead	silver	gold	platinum
mercury	arsenic	selenium	tin	radon
uranium	plutonium	iodine	zirconium	tungsten

ELEMENTS IN HISTORY:

Some of these elements were known all the way back in ancient times. Silver and gold have been used for thousands of years. Ancient peoples also knew about iron, tin, lead, copper, sulfur, and mercury. (The ancients didn't understand what a chemical element was, however, and they also considered fire, water, earth and air to be elements.) Other elements were not discovered until modern times. In the 1800s, electricity was used to discover magnesium, potassium and sodium. In the 1900s, radioactive elements such as uranium and plutonium were discovered. (These two elements were named in honor of the recent discovery of Uranus and Pluto.) The elements with numbers above 100 are artificially made in nuclear reactors.

Activity #4 A scavenger hunt

Round up some boxes, cans and tubes that you have around the house and see how many of these elements you can find. Put a checkmark in the box if you find that element. (Notice the two empty spaces at the bottom. Write in two more elements that you find.)

	cereal	toothpaste	vitamins	aspirin or pain reliever	cough/cold medicine	can of soup
calcium						
chlorine						
copper						
fluorine						
iodine						
iron						
magnesium						
sodium						
zinc						

So what are <u>ingredients</u> made of? Is there a recipe to make salt or sugar? Yes, there is! The ingredients for these ingredients are the 109 elements. For example, to make salt, you need two chemical elements: sodium and chlorine. If you combine these two elements together, you will get table salt. The recipe for sugar calls for three elements: carbon, hydrogen, and oxygen.

A cooking recipe looks like this:

Sugar cookies:

2 cups flour	1 egg
1/2 cup sugar	1 teaspoon vanilla
1/2 cup butter	1/2 teaspoon baking soda

A chemical recipe looks like this:

glucose sugar = $C_6H_{12}O_6$

The letters are abbreviations, or **symbols**, for elements. C stands for carbon, H stands for hydrogen, and O stands for oxygen. The numbers below the letters tell you how many atoms of each one go into the recipe. This recipe calls for 6 atoms of carbon, 12 atoms of hydrogen and 6 atoms of oxygen. Just like with a cooking recipe, you can make a small, medium, or large batch. Theoretically, you could make a batch as small as a few molecules or large enough to fill a dump truck. As long as you keep the number of atoms in this ratio-- 6, 12, 6-- you will get glucose sugar. (But what are you going to do with several dump trucks loads of glucose sugar?!)

Let's look at the recipe for water:

water = H_2O

The elements in this recipe are similar to the one for glucose sugar, except that there is no carbon. You will need hydrogen and oxygen. How much of each? There are 2 hydrogen atoms and... but there is no number after the O. Now what? If you don't see a number, it means there is only one. Scientists decided a long time ago that it was too much work to put in all the 1's in the recipes, so they agreed to just leave them out. If you don't see a number after the letter, that means there is only one. (You could think of the 1's as being invisible.)

So, that's 2 atoms of hydrogen and 1 atom of oxygen. How much of the recipe will you make? A glass of water, or enough to fill a swimming pool?

What about the recipe for salt?

table salt = NaCl

We don't see any numbers here at all. That means one atom of each. What are the ingredients? **Na** is the letter symbol for sodium (explanation in a later chapter) and **Cl** is the abbreviation for chlorine (yes, chlorine goes in your pool, too, but it is also in salt).

Let's look at the recipe for baking soda:

baking soda = $NaHCO_3$

That's 1 atom of sodium, 1 atom of hydrogen, 1 atom of carbon, and 3 atoms of oxygen. Those are all the same ingredients we just used to make salt and sugar, but if you combine them in this proportion you will make baking soda. (Baking soda's job in kitchen recipes is to make things "puff up" in the oven.)

What else can we make with chemical elements? Here are some recipes that aren't edible:

sand = SiO_2

talc (soapstone) = $Mg_3Si_4O_{10}$

gold = Au

pyrite ("fool's gold") = FeS_2

These four are mineral recipes. We have some new elements in these recipes. **Si** is silicon, **Mg** is magnesium, **Fe** is iron, **S** is sulfur, and **Au** is gold. You can see that the recipe for gold is pretty simple-- it's just the element gold with nothing added. The recipe for talc is a bit more complicated.

Want to see a really long recipe?

a mineral called Vesuvianite = $Ca_{10}Mg_2Al_4(SiO_4)_5(Si_2O_7)_2(OH)_4$

Wow! We won't be cooking up any of that!

* *

Activity #5

Recipes can be doubled, or tripled, or cut in half, depending upon how much of the product you want to make. See if you can figure out the answers to these recipe questions. (Note: We're just using an imaginary "scoop" that accurately counts the atoms for us. In real life, measuring elements and mixing them requires special equipment and more difficult math.)

1) The recipe for the mineral calcite is $CaCO_3$. If we use 2 "scoops" of Ca (calcium), how many "scoops" of the other ingredients will we need? C = ____ O = ______

2) The recipe for the mineral called cinnabar (sounds delicious, but it's poisonous) is HgS. If we make a batch of cinnabar using 3 "scoops" of Hg (mercury), how many "scoops" of S (sulfur) will we need? ________

3) You are a practical joker and want to make a batch of fool's gold to trick a friend. The recipe for fool's gold is FeS_2. If you use 4 "scoops" of S (sulfur) how many "scoops" of Fe (iron) will you need? ______

4) A mineral gemstone called zircon can sometimes resemble a diamond. The recipe to make zircon is $ZrSiO_4$. If you use 2 "scoops" of Zr (zirconium), how many "scoops" of the other ingredients will you need? Si = ______ O = ______

5) How many "scoops" of hydrogen are needed for 10 batches of the recipe H_2O? __

Activity #6

See if you can match the element with the meaning of its name.

1) Named after Alfred Nobel, inventor of dynamite and founder of the Nobel Prizes ____________

2) Named after Vanadis, a goddess from Scandinavian mythology _____________

3) Named after Johan Gadolin, a Finnish chemist ______________

4) Named after Poland, the country in which famous chemist Marie Curie was born ___________

5) Named after Albert Einstein ______________

6) Named after the city of Berkeley, California ______________

7) Named to honor our planet, Earth, but using the Greek word for Earth: "Tellus" _____________

8) Named for the area of Europe called Scandinavia (Norway, Finland, Sweden, Denmark) ____________

9) Named for the Swedish town of Ytterby ______________

10) Named for Niobe, a goddess in Greek mythology who was the daughter of Tantalus _____________

11) Named for Tinia, a mythological god of the Etruscans (in the area we now call Italy) ____________

12) Named for Stockholm, Sweden ______________

13) Named in honor of the discovery of the planet Neptune _______________

14) Named in honor of Marie and Pierre Curie, who discovered radium and polonium _______________

15) Named after the Roman messenger god, Mercury, who had wings on his feet ______________

16) Named after the Greek god Tantalus (father of Niobe) _________________

17) Named in honor of the discovery of the asteroid Ceres _______________

18) Named after France, but using its ancient name, Gall _________________

19) Named after the moon, but using the Greek word for moon, "selene" _____________

20) Named for its really bad smell, using the Greek word "bromos" which means "stench" ____________

21) Named after the Latin word for rainbow, "iris," because it forms salts of various colors __________

22) Named after Thor, the Norse god of thunder ____________

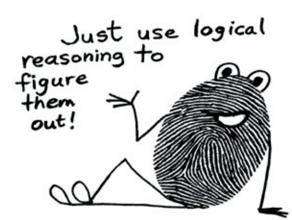
23) The name comes from the German word "Kupfernickel," meaning "Satan's copper" ______________

24) The name comes from the German "Kobald," a mythological gnome who lived in mines ____________

25) Named for its color, yellowish-green, using the Greek word for this color: "chloros" _____________

THE POSSIBLE ANSWERS:

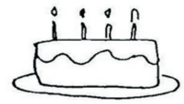
berkelium, bromine, cobalt, cerium, chlorine, curium, einsteinium, gadolinium, gallium, holmium, iridium, mercury, neptunium, nickel, niobium, nobelium, polonium, scandium, selenium, tantalum, tellurium, thorium, tin, vanadium, ytterbium



Activity #7 The Chemical Compounds Song

Here is a very silly song about chemical recipes. The audio track for this song is on the CD that comes with this curriculum. There are two versions. The first one has the words so you can learn how they match the tune. The second version is accompaniment-only so you can sing it yourself! When singing it becomes easy, try it as a hand-clap game, like "Miss Merry Mack" or "Down, Down Baby." You don't even need the music track if you use it as a hand-clap game.

The Chemical Compounds Song

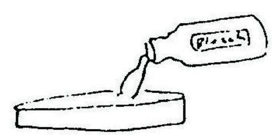


Today was Mama's birthday; I tried to bake a cake.
I didn't use a recipe, that was my first mistake!

I put in lots of H_2O, 3 cups NaCl,
Some $NaHCO_3$, and other things as well.

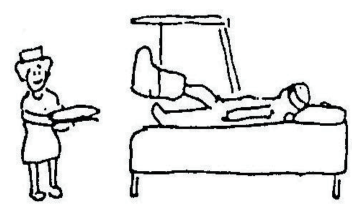
I poured it in a non-stick pan (Teflon, C_2F_4)
I popped it in the oven (it cooks with CH_4).

I set the oven way too hot, the cake got black and charred.
Oh, why did I make birthday cake? I should have bought a card!



I had to clean and scrub the pan, so Mom would never know.
First I tried to bleach the pan with NaClO.

I needed something stronger, so I tried some HCl.
I added grit, SiO_2, and FeO, as well.



Then something awful happened, I'll never know just why.
I woke up in the hospital with stitches near my eye!

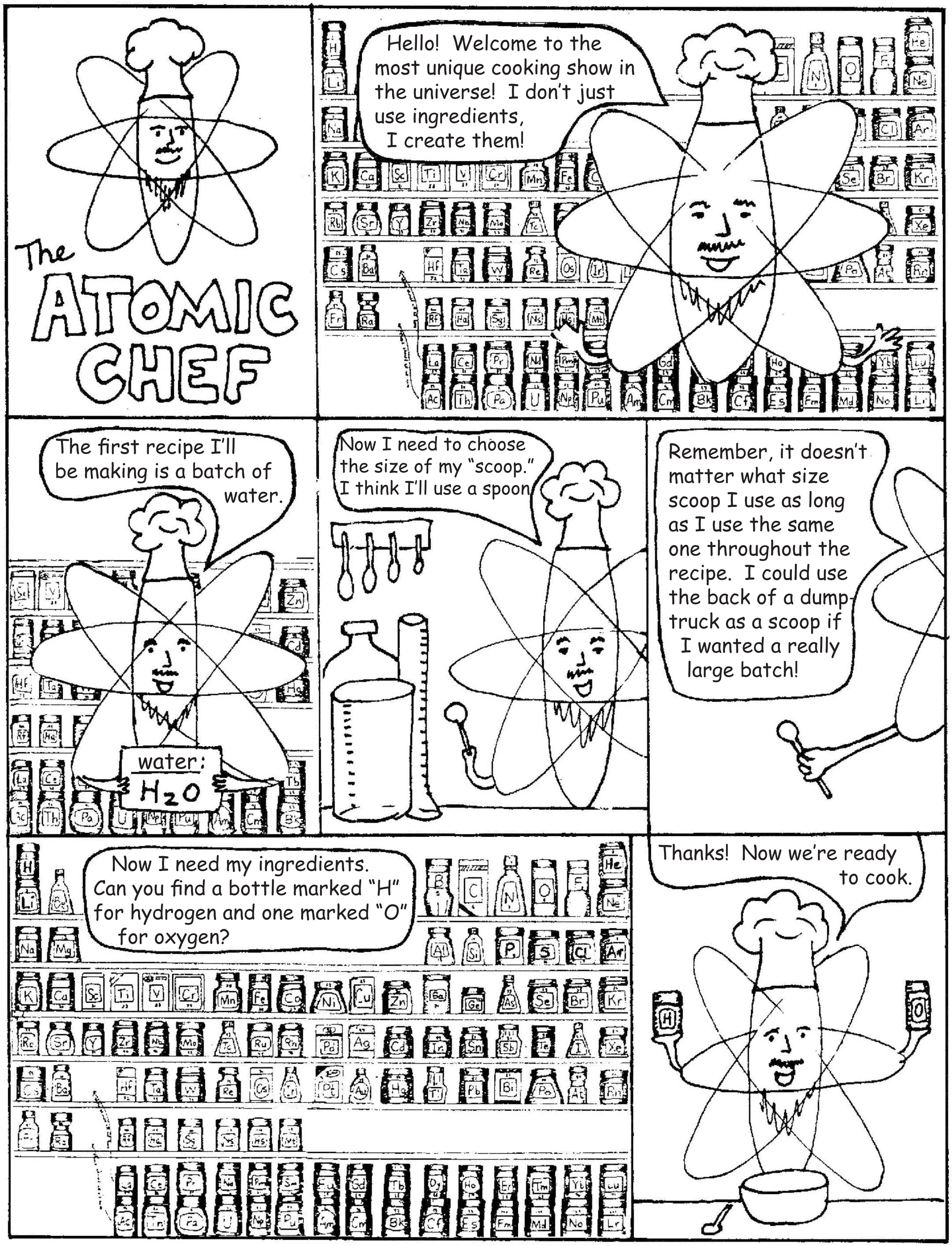
My leg was in a plaster cast of $CaSO_4$.
The nurse brought $Mg(OH)_2$ and $MgSO_4$.

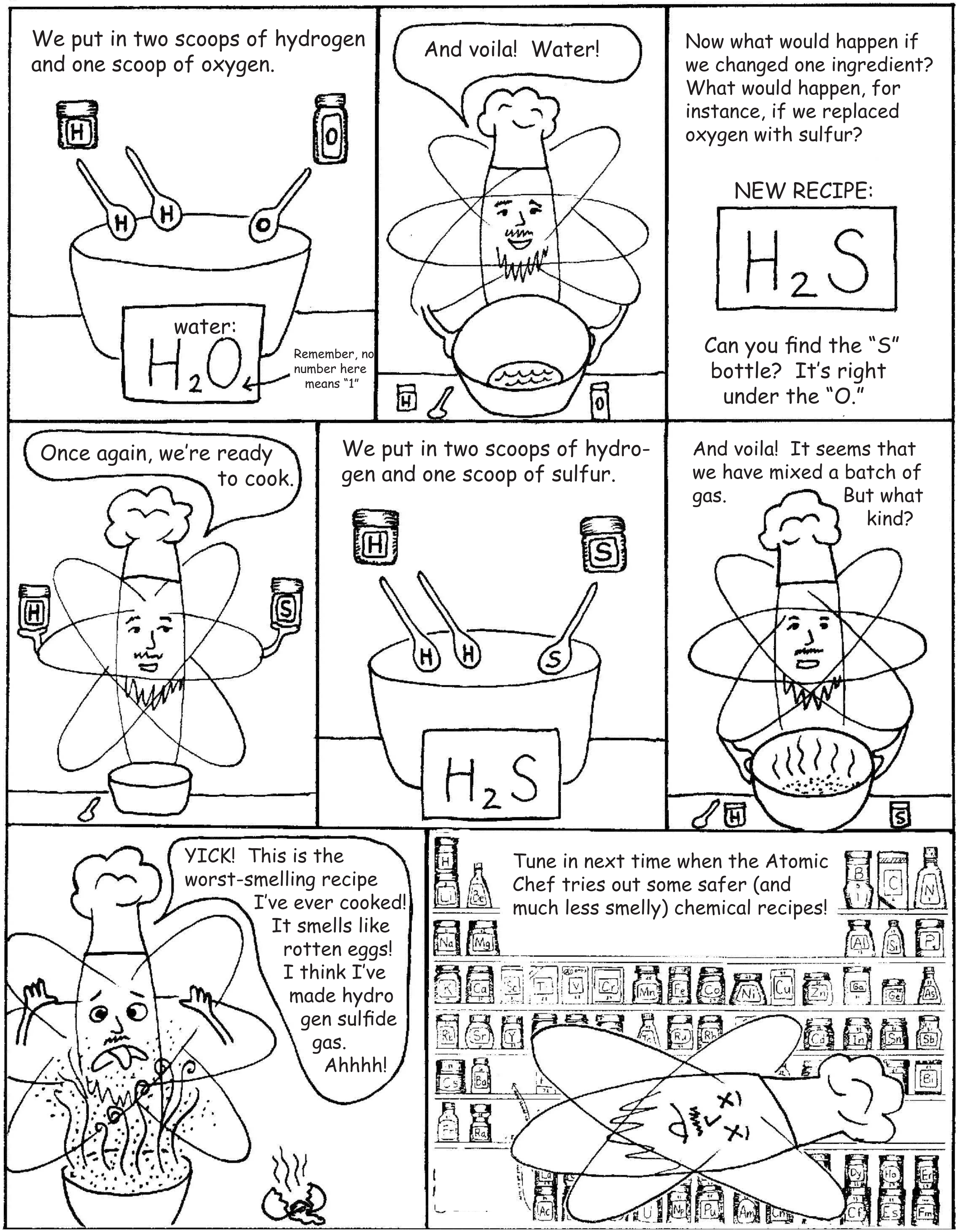
Next year for Mama's birthday, I'll buy a cake, instead,
'Cause if I tried to bake again, I think I'd end up dead!

$H_2$0 = water
NaCl = salt
$NaHCO_3$ = baking soda
C_2F_4 = Teflon
CH_4 = natural gas
NaClO = bleach

HCl = hydrochloric acid
SiO_2 = sand
FeO = rust
$CaSO_4$ = plaster
$Mg(OH)_2$ = milk of magnesia (good for bowels)
$MgSO_4$ = Epsom salt (good for skin)

And now it's time for our first episode of The Atomic Chef:





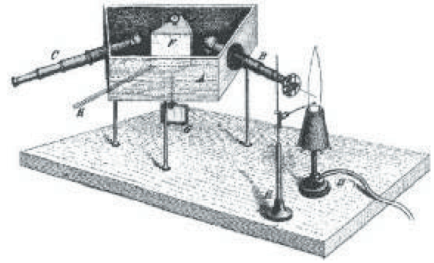
Tune in again at the end of the next chapter for more adventures with the Atomic Chef!

CHAPTER 2: THE PERIODIC TABLE

Have you ever read stories from medieval times where a person called an "alchemist" tried to make gold? The alchemists were part scientist and part magician, and although they experimented with other forms of chemistry, they are famous for trying to make gold. They boiled up mixtures of every substance they could find: copper, tin, lead, iron, coal, silver, mercury, unusual rocks, gold-colored minerals, medicinal plants, parts of animals, and anything else they could think of. They even said magic spells over their boiling pots, but they never produced a single drop of gold. What the alchemists did not know is that gold is one of the basic ingredients in the Kitchen Cupboard of the Universe. They thought gold had a recipe like water or hydrogen sulfide. But you can't make gold. It's a basic ingredient that comes naturally in the Earth. The letter symbol for gold is Au. Can you find gold in the Kitchen Cupboard of the Universe? What number is on the bottle?

The confusion of the alchemists is very understandable. Metals don't come with labels on them telling you what they are made of. Bronze and copper were both metals. Bronze could be melted down into its two ingredients: copper and tin. The alchemists wondered why copper couldn't be boiled down into its ingredients. They didn't know that copper, like gold, is an element. It was only after years of experimenting that ancient scientists began a list of substances that they believed could not be reduced down any further. During the 300 years between 1200 AD and 1500 AD, the list of substances believed to be basic ingredients of the universe grew to include carbon, sulfur, iron, copper, silver, tin, mercury, lead, arsenic, antimony, bismuth, zinc, platinum and gold. (The alchemists eventually had to give up and admit that gold had no recipe.) All of these elements are in our kitchen cupboard of the universe, though they are not sitting all in a row.

Several hundred years went by with no new discoveries of any more basic ingredients. Then, in the 1700s, there was a huge explosion of activity in the field of chemistry. With the discovery of electricity, the invention of a machine that could analyze light (the spectrometer, shown on the right), and great progess in the field of mathematics, these "modern" chemists of the 1700s could do experiments that were far beyond anything the ancient chemists had ever done. These new chemists began calling the basic ingredients "elements," and by the year 1800, the official list of elements had grown to include phosphorus, cobalt, nickel, hydrogen, fluorine, nitrogen, oxygen, chlorine,

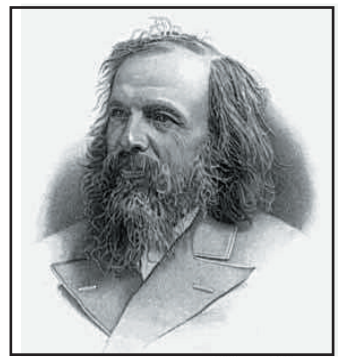


a spectrometer

manganese, magnesium, molybdenum, tellurium, tungsten, zirconium, strontium, titanium, yttrium, and chromium.

The list kept growing during the 1800s, and by the middle of the century there were over 60 elements on the list. By now there was no confusion about what an element was. Scientists understood very clearly that elements were the basic ingredients of the universe. An element could not be boiled down into anything else. They also understood that there was probably a limited number of elements, and once they were all found the fun of discovery would be over. Thus. there ensued a sort of international "scavenger hunt" for new elements, with every chemist dreaming of being one of the lucky winners who would find one of the remaining unknown elements.

Amidst all this frenzy for discovering the remaining elements, a Russian chemist named Dmitri Mendeleyev (men-dell-AY-ev) began giving chemistry lectures at St. Petersburg University in 1867. As Mendeleyev studied in order to prepare for his lectures, he began to have the feeling that the world of chemistry was like a huge forest in which you could easily get lost. There were no trails or maps, and there were so many trees! It was all a muddled mess of elements, mixtures, oxides, salts, acids, bases, gases, liquids, crystals, metals, and so much more. The subject of chemistry was confusing to his students, and he could see why. There was no overall structure to this area of science. It was just a massive collection of facts and observations about individual substances. Each scientist had a different way of arranging the substances, and that confused students. Some scientists grouped all the gases together, while others grouped them by color, or listed them from most to least common, or even alphabetically. Was one arrangement better than all the rest? Mendeleyev decided that he would search for some kind of overall pattern that could be applied to chemistry, making it easier for his students to learn.



Mendeleyev began by cutting 63 squares of cardboard, one for each of the elements that were known at that time. On each card he wrote the name of an element and all its characteristics: whether it was solid, liquid, or gas, what color it was, how shiny it was, how much it weighed, and how it reacted to other elements. He then laid out the cards in various ways, trying to find an overall pattern. One evening he was sitting, as usual, in front of his element cards, staring at them and trying to think of some new way to arrange them. The hour became late and he fell asleep over his work. While he slept, he dreamed about the cards. In his dream he saw the cards line up into rows and columns, creating a rectangular "table."

When he woke up, he realized that his brain had solved the problem: the way to arrange the elements was first by weight, then by chemical properties. He began

laying them out in order of their weight, starting with the lightest, hydrogen. Then came helium, lithium, berylium, boron, carbon, nitrogen, oxygen, and fluorine. The next element was sodium. Instead of putting it next to fluorine, he put it underneath lithium because it had similar chemical properties to lithium. So the second line began with sodium. Then he began filling in with the elements arranged by weight again: magnesium, aluminum, silicon, phosphorus, sulfur, and chlorine. When he got to the next element, potassium, he decided to start a third line, putting potassium right underneath sodium because they had similar chemical properties. Then it was back to listing them by weight: calcium, titanium, vanadium, chromium... As he laid the cards out in order of their weight, every once in a while, or "periodically," he had to go back and start a new row so that elements that had similar chemical properties would be in the same column. This method of arranging the elements became known as the "Periodic Table" because it is a table (chart) that has patterns that repeat periodically.

This is how the main part of Mendeleyev's chart looked.

lithium	beryllium	boron	carbon	nitrogen	oxygen	fluorine
sodium	magnesium	aluminum	silicon	phosphorus	sulfur	chlorine
potassium	calcium	eka-boron	titanium	vanadium	chromium	manganese
copper	zinc	eka-aluminum	eka-silicon	arsenic	selenium	bromine
rubidium	strontium	yttrium	zirconium	columbium	molybdenum	?
silver	cadmium	indium	tin	antimony	tellurium	iodine
cesium	barium					

Mendeleyev ran into some problems with his Periodic Table. It seemed that there were awkward areas where things did not fit perfectly. He guessed that this was because there were cards missing. His set of 63 cards must be incomplete. Mendeleyev started leaving blank spaces in his chart where he believed there was a missing element. He began to predict what these elements would be like when they were discovered. He even gave them temporary names. The empty space under boron and aluminum he named "eka-boron." ("Eka" means "one more" in the Sanskrit language.) The empty space under carbon, silicon, and titanium was "eka-silicon."

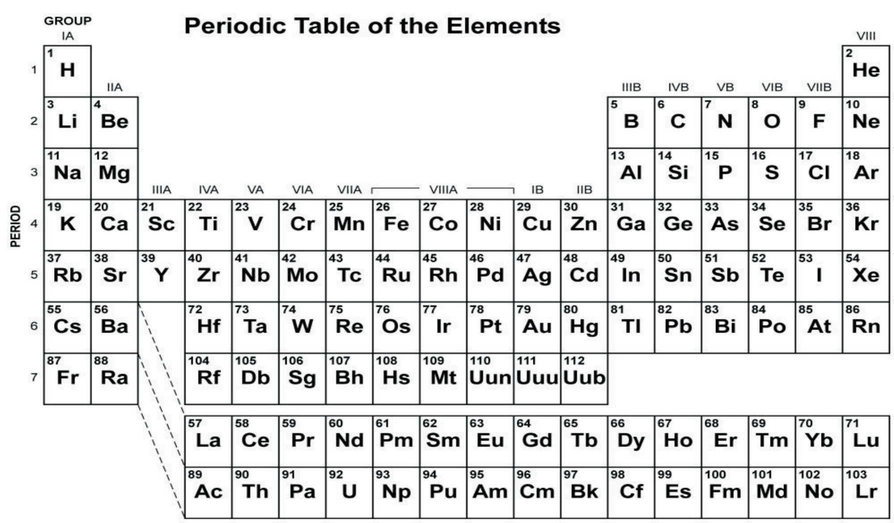
Many chemists of Mendeleyev's day laughed at him for trying to predict the discovery of new elements. They did not believe in his Periodic Table and thought he was a fool for making up all these fictional elements-- elements that did not even exist!

In 1875, one of Mendeleyev's predictions came true. A new element was discovered by a French chemist with a long name: Paul Emile Lecoq de Boisdaubran (the man shown here on the right). He had decided to name this new element after his country, France, but using a very old word for France: Gall. He named the element "gallium." Mendeleyev listened to the description of this new element and proudly announced that gallium was, in fact, the missing element he had called eka-aluminum. Mendeleyev had already known what this element would be like. He had correctly predicted its weight, its density, its color, and its chemical properties! Some chemists thought this was just a coincidence and waited to see if any more of his predictions would come true.

After the discovery of gallium, Mendeleyev became braver about making predictions. He announced that sometime soon a scientist would discover a new element that would be a dark gray metal with a weight that was 72 times heavier than hydrogen, a specific gravity of about 5.5, and having the ability to combine with oxygen to make oxide compounds that are very hard to melt even in a hot fire. Fifteen years after this prediction, a scientist in Germany discovered a new metal that he named germanium (after Germany, of course). As you might guess, the characteristics of this new metal were exactly what Mendeleyev had predicted! The scientific world was stunned as they compared Mendeleyev's predictions with the actual experimental results for this new metal-- they were almost identical! Germanium was Mendeleyev's "eka-silicon." (Mendeleyev was happy to have a real name for "eka-silicon" and gladly replaced it with "germanium.")

Eventually, Mendeleyev and his Periodic Table became famous all over the world. He received gold medals and honorary degrees from universities in other countries, and was invited to join important scientific societies. Sadly, however, his homeland of Russia refused to acknowledge him. When his name was presented to the Russian Academy of Sciences he was rejected. Mendeleyev was looked down upon because he said things the Russian government did not want to hear. He told them they needed to be careful with Russia's supply of crude oil because it was a precious resource and would not last forever. He said that Russia's technology was lagging behind that of other nations and they needed to catch up. Sadly, the government didn't really care about improving the country, and they ingnored Mendeleyev's advice.

After Mendeleyev, chemists continued to discover elements. Every time a new element was discovered it was added to the Periodic Table. The number of elements grew from 63 to over 100. Some adjustments had to be made to Mendeleyev's original table in order to accommodate all the new discoveries. They added a middle section, plus two more rows at the bottom. This is how the Table looks today:



Periodic Table of the Elements

PERIOD	GROUP IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA			IB	IIB	IIIB	IVB	VB	VIB	VIIB	VIII
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub						

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Many decades after Mendeleyev's death, scientists realized that there was nothing on the Periodic Table to commemorate the very man who had created it. So in 1955, when a new element was discovered, the discoverers decided to honor the memory of Dmitri Mendeleyev by naming the new element "Mendelevium." It is number 101 on the Periodic Table and its letter symbol is Md.

Activity #1

Check out this amazing Periodic Table! It's so large that it covers a whole wall! It is located at the Ruth Patrick Science Education Center in South Carolina. Each box in this table contains an actual sample of the element (except for the elements that are either too dangerious--such as highly radioactive elements--or elements that are manufactured in nuclear labs and only exist for a few seconds at a time).

If you would like to view this image on your computer screen, the address is:
http://rpsec.usca.edu/Utilities/Pictures/Facility/PeriodicTable.jpg
If you'd like more information on this science center, go to: **http://rpsec.usca.edu/**

Activity #2 **An interactive Periodic Table** (on-line)

Here is an on-line Periodic Table that is interactive. (It must be viewed on a computer that is hooked up to the Internet.) You can click on an element and a box pops up, giving you a larger picture and more information about that element. As you explore this table, notice how many of the elements are metals.

http://www.popsci.com/popsci/periodictable

Activity #3 What are these elements?

Use the "Quick Six" playing cards to find these elements.

1) Find an element that is used to make matches, fireworks, and detergents. ________________

2) Find an element that is used in toothpaste, but is also one of the ingredients in Teflon (The recipe for Teflon is in the "Chemical Compounds Song.") _______________

3) Find an element that is found in chalk, plaster, concrete, bones and teeth. __________

4) Find an element that is used in lasers, CD players and cell phones. ____________

5) Find an element that is used to repair bones and is also used in paints. _____________

6) Find an element that is found in sand, clay, lava, and quartz. ____________

7) Find an element that is rose-colored and is used to make catalytic converters and headlight reflectors for cars. _____________

8) Find an element that is used as a disinfectant for cuts and scrapes, is used to make lamps and photographic film, and is needed by our thyroid glands. ____________

9) Find an element that is used in stadium lights and in large-screen TVs. _____________

10) Find an element that is used in dentistry and jewelry, and is also used to purify hydrogen gas and to treat tumors. ______________

11) Find an element that is an ingredient of pewter, and can also be mixed with copper to make bronze. _____

12) Find an element that is used to vulcanize rubber and is a component of air pollution. _________

13) Find an element that is used to sterilize swimming pools. _______________

14) Find an element that is used in lightbulbs and lasers and won't bond with other elements. ____

15) Find an element that makes up most of the air we breathe. ______________

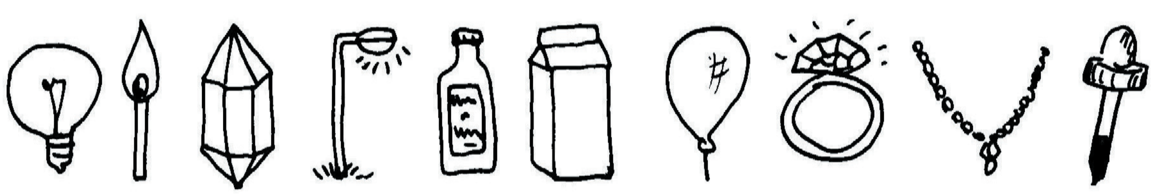
16) Find an element that has no neutrons. ____________

17) Find an element that makes diamonds, graphite and coal. ________________

18) Find an element that is used in antiseptic eye washes but is also used to make heat-resistant glass, as well as being used in nuclear power plants. ___________

19) Find an element that you eat in bananas but can also be used for gunpowder. ____________

20) Find an element that is used in lights that need to flash brightly, such as camera flashes and strobe lights. _________________



Activity #4

Here is a just-for-fun puzzle using the symbols (letter abbreviations) for some of the elements. Write the symbols in the blanks to make some silly riddles.

____ ____ ____ did the ____ ____ ____ ____a ____
tungsten hydrogen yttrium molybdenum uranium selenium sulfur yttrium

____ ____e____, ____ ____e____," ____ ____ ____ the
carbon helium phosphorus carbon helium phosphorus tungsten helium nitrogen

____ ____d'____ ____ ____e ____ll a____art? ____ ____ ____
boron iridium sulfur carbon silver iron phosphorus Helium tungsten arsenic

____ ____ l ____ ____g ____ ____ ____r the ____ ____d
fluorine iodine lithium nitrogen indium fluorine oxygen boron iridium

____ ____ ____ ____ad the da____ ____ ____ ____.
tungsten hydrogen oxygen hydrogen yttrium oxygen fluorine fluorine

Here's another one:

____ ____ ____ do ____ ____ ____ ____t ____ ____ ____
tungsten hydrogen astatine yttrium oxygen uranium germanium tungsten helium nitrogen

____ ____ ____ ____r ____ ____ ____ a ____ ____ ____ ____e
yttrium oxygen uranium carbon osmium sulfur sulfur vanadium americium phosphorus iridium

with a ____ ____ ____? A ____rr ____ ____ ____ed ____ ____!
molybdenum uranium selenium tellurium iodine fluorine iodine carbon astatine

And one last riddle:

____ ____ ____ ____ ____e ____ ____a ____ a____ R____ ____ ____'____
tungsten hydrogen astatine tungsten erbium Barium thulium nitrogen neodymium oxygen bismuth nitrogen sulfur

____ ____ ____ ____ ____ a____ ____r t____ ____ ____ ____e
neon tungsten nitrogen americium einsteinium fluorine tellurium helium yttrium tungsten erbium

____ ____ ____ ____ ____ ____ ____ a ____r?
ruthenium nitrogen oxygen vanadium erbium boron yttrium calcium

____ ____ ____a____ a____ R____ ____ ____ ____ ____!
fluorine lanthanum thulium nitrogen neodymium iodine boron boron oxygen nitrogen

Ativity #5 **The Periodic Jump Rope Rhyme**

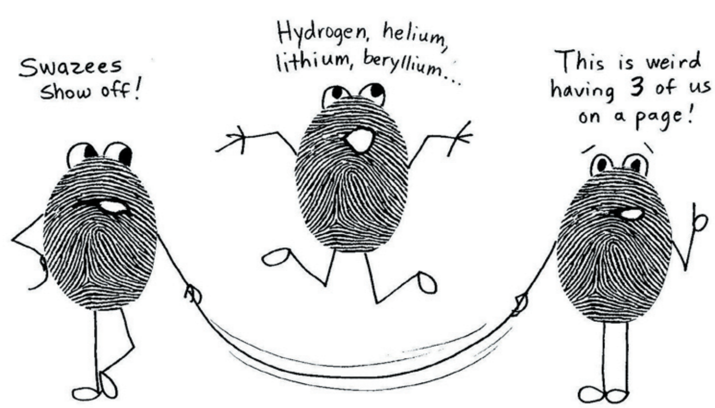
Use the first four rows of the Periodic Table as a jump rope rhyme. Why not? Most jump rope rhymes are pretty silly and don't make sense, anyway! The audio track on the CD will show you how to say the rhyme. Then try it on your own. If you mess up and trip over the rope, you have to start at the beginning again. Can you get to krypton? Can your friends do it?

Hydrogen, helium,
Lithium, beryllium
Boron, carbon
Nitrogen and Oxygen
Fluorine, neon

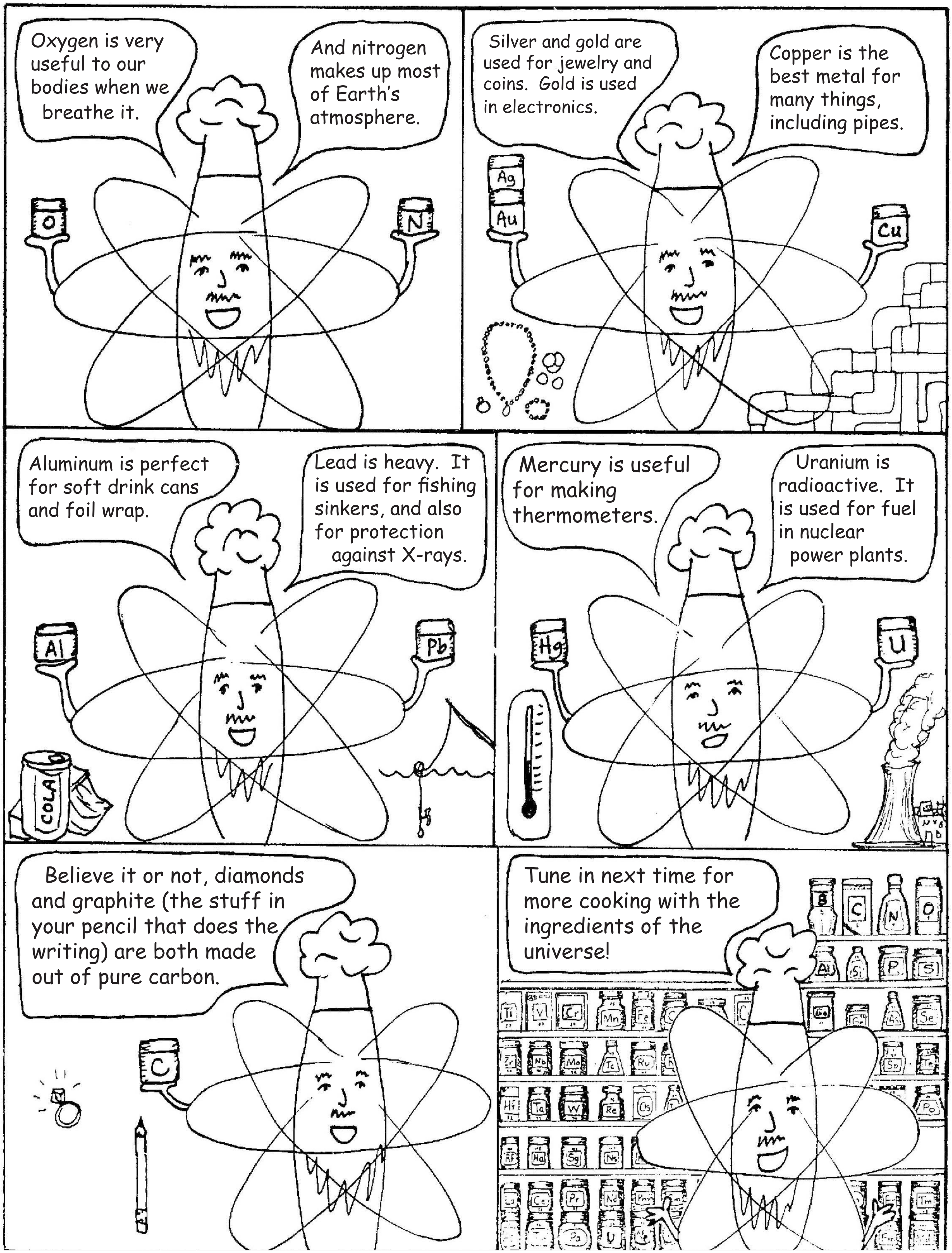
Sodium, magnesium
Aluminum and silicon
Phosphorus, sulfur
Chlorine, argon

Potassium, calcium
Scandium, titanium, vanadium, chromium, manganese!

FeCoNi's my CuZn
His last name is Gallium
He lives in Germanium
Once he ate some arsenic, thought it was selenium
Drank it down with bromine. Now he's strong as krypton!



The ATOMIC CHEF
Hello, and welcome back to the most unique cooking show in the whole universe!
Today's topic is "ingredients you can use right off the shelf." That's right-- today we will not be using any recipes!
Let's look over our Kitchen Cupboard of the Universe and see if we can find something we can use.
What about these bottles here on the end?
He, Ne Ar, Kr, and Xe.
"He" is helium. Hurray for helium! It makes our balloons float! You can use helium straight off the shelf, no recipe needed. "Ne" is neon. It's pretty cool, too. Neon signs are very bright. They look neat.
He
Ne
NEON
Argon, krypton and xenon are very useful in light bulbs, especially really bright ones like camera flashes.
And in lighthouses.
Ar
Kr
Xe


Oxygen is very useful to our bodies when we breathe it.
And nitrogen makes up most of Earth's atmosphere.
O
N
Silver and gold are used for jewelry and coins. Gold is used in electronics.
Copper is the best metal for many things, including pipes.
Ag
Au
Cu
Aluminum is perfect for soft drink cans and foil wrap.
Lead is heavy. It is used for fishing sinkers, and also for protection against X-rays.
Al
Pb
COLA
Mercury is useful for making thermometers.
Uranium is radioactive. It is used for fuel in nuclear power plants.
Hg
U
Believe it or not, diamonds and graphite (the stuff in your pencil that does the writing) are both made out of pure carbon.
C
Tune in next time for more cooking with the ingredients of the universe!

ACTIVITY IDEAS FOR CHAPTER 1

1) GROUP GAME: "Symbol Jars"

The object of this game is to learn the letter symbols of some of the common elements. Students need not have any previous knowledge. If players do already know some of the symbols, they can still play along with those who are beginners.

You will need: photocopies on card stock, scissors, pencils or crayons

Set up: Photocopy the pattern page, (the empty bottles, page 84), onto white card stock. Make enough copies so that you have a bottle for each element you want to learn. Cut out the bottles. Write an element's symbol on the bottle, then write the name of the element on the back. (Important: Make sure you don't use anything that will bleed through to the other side! Also, don't press too hard, or your letters might show through to the back. This isn't the time to practice your engraving skills!) You could also reverse this, and put the name on the front and the symbol on the back. Either way is fine.

How to play: Before you begin, make sure each player has a little slip of paper with his name on it. Lay the jars out on the table in random fashion. Each player must "call" the jar he wants to play by saying the letter symbol. For example, a player might say, "C." Then the player has a choice: he can either "guess" or "peek."

If the player chooses "guess," he must say the name of the element that is represented by that symbol. After he says the name, he checks his answer by turning over the jar and reading the name on the back. If he is correct, he gets to pick up that jar and keep it. If not, he must leave the jar on the table.

If the player doesn't know a symbol and wants to learn it, he chooses the "peek" option. The player still begins by "calling" the jar he wants to play by saying the letter symbol. Then the player states his option, "peek," and turns the jar over to read the name on the back. After returning the jar to its original position, the player may then "reserve" the jar for his next turn by putting his slip of paper (with his name on it) on top of the bottle. No other player may call that jar while the name slip is on it. When that player's next turn comes around, he can call that jar again, but this time using the "guess" option (assuming he does remember the name on the back-- if he doesn't, he can always use the "peek" option again). If he guesses correctly, he keeps the jar.

The game is over when all the jars have been taken.

2) GROUP GAME: "Quick Six" (Round one-- we'll play it later with more cards!)

The object of this game is to become familiar with the names and numbers of the elements from hydrogen to xenon. Players do not need any previous knowledge for this game.

You will need: scissors, photocopies of the pattern pages (85-90) on white card stock, and colored pencils if you would like the students to color the cards

Set up: Cut apart the cards. If you would like the students to add color to the cards, provide colored pencils and some extra coloring time.

How to play:

The object of the game is to be the first player to collect six cards.

Decide which player will be the "caller." This player must read from the list below instead of being one of the card players. If an adult is supervising the game, this is the obvious adult job. An adult caller may want to choose particular attributes from the list below to emphasize facts recently learned. It is easiest to go down the list in order, but the caller need not go in order, and may also use items from the list more than once (as long as the caller is being fair and is not purposely aiming to benefit any one card player, of course!) Feel free to add your own ideas to the list given below!

Each card player receives five cards, which he places face up in front of him. The rest of the cards go face down in a draw pile. The caller reads one of the attributes from the list (the first on the list if they are going in order). Each player looks at his five cards to see if he has a card that has that attribute. If he does, he slaps his hand down on the card. The caller looks to see who is the first player to slap his hand down. That player then shows the card under his hand. If the caller agrees that this card qualifies, then the player may remove that card from the line up and put it face down into a "keeper" pile. Then he draws a card from the draw pile to replace that card and restore him to five cards, face up.

The caller then reads off another attribute from the list and the game continues in this manner until one player has six cards in his "keeper" pile. If no player has a card that qualifies, the caller simply goes on to the next one on the list.

If you reach the end of the list below, just start over at the beginning again.

Game takes 5-20 minutes to play. Often there is time to play several games in a row. You can switch callers between games if you want to.

Number has a 3 in it
Name has two syllables
Used in lasers
Has something to do with the color green
Named after someplace in Scandinavia
Has something to do with teeth
Starts with the letter C
Number has a 5 in it
Name has something to do with color
Used to make tools of some kind
Is named after a city (not a country)
Name has three syllables
Is used to make jewelry
Named after a country
Used for something that burns
Named after something in the solar system
Number has a 7 in it
Is named after a country (not a city)
Used in fireworks
Has something to do with bones
Name starts with a vowel
Gemstones are made from it
Used in steel production
Used to repair the human body
Used in light bulbs
Is found as a gas in the air around us
Has something to do with eyes
Conducts electricity
Last three letters of the name are I-U-M
Name is from a Latin word
Is used in batteries or fuel
Has something to do with glass
First letter of name does not match first letter of the symbol
Is found in some kind of gemstone
Name begins with the letter S
Name comes from a chemical compound
Name starts with the "K" sound (C or K)
Is used in magnets of any kind
Used in something that makes light
Used to make coins
Contains one of these letters: X, Y, or Z
Name has four syllables
Number has a 1 in it

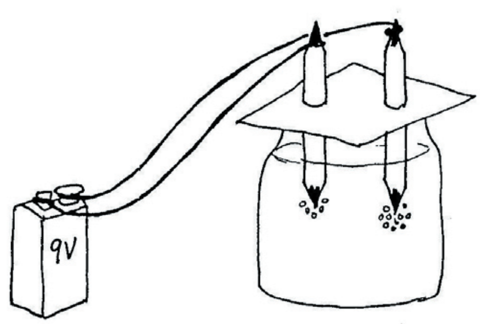
TUNE IN FOR ROUND TWO AFTER CHAPTER 4! MORE CARDS! MORE CLUES!

3) LAB EXPERIMENT: "A Recipe in Reverse" (Electrolysis of water)

In this experiment, you will start with H_2O and reduce it into its ingredients, H and O.

<u>You will need</u> a glass jar, a 9V battery, a piece of cardboard (cereal box is fine), two copper wires (stripped at both ends), two pencil stubs (sharpened at both ends)

<u>How to set it up</u>:



<u>What will happen:</u>

You will see bubbles forming around the ends of both pencils. If you look carefully, you will notice that there are about twice as many bubbles on one pencil as the other. Have the students guess which is which, by thinking about the recipe H_2O. For every oxygen there are two hydrogens...

4) SONG: "The Chemical Compounds Song" activity

<u>You will need</u>: the audio CD that came with this curriculum

Here is an activity you can do with this song. It can be done in pairs or in a group, whatever works in your situation. The nice thing about this activity is that the students themselves can input their ideas, since they are likely to be the experts on hand-slapping games. Use the song as the chant for any type of hand-slapping game, such as "Miss Mary Mack." ("Miss Mary Mack, Mack, Mack, all dressed in black, black, black...") The students may be able to suggest their favorite hand-slapping patterns.

5) "MAKE FIVE" A game about mineral recipes

(This game is recommended for older students, or those who are very enthusiastic about rocks and minerals. If "Symbol Jars" is enough, you can skip this game.)

By definition, a mineral has a definite chemical composition-- a recipe. In this game you will be introduced to the recipes for some common minerals. It's also an opportunity to keep on learning all those letter abreviations (symbols).

You will need:
- copies of the pattern pages copied onto card stock
- scissors
- white glue (if you are assembling the paper dice)

Preparation:

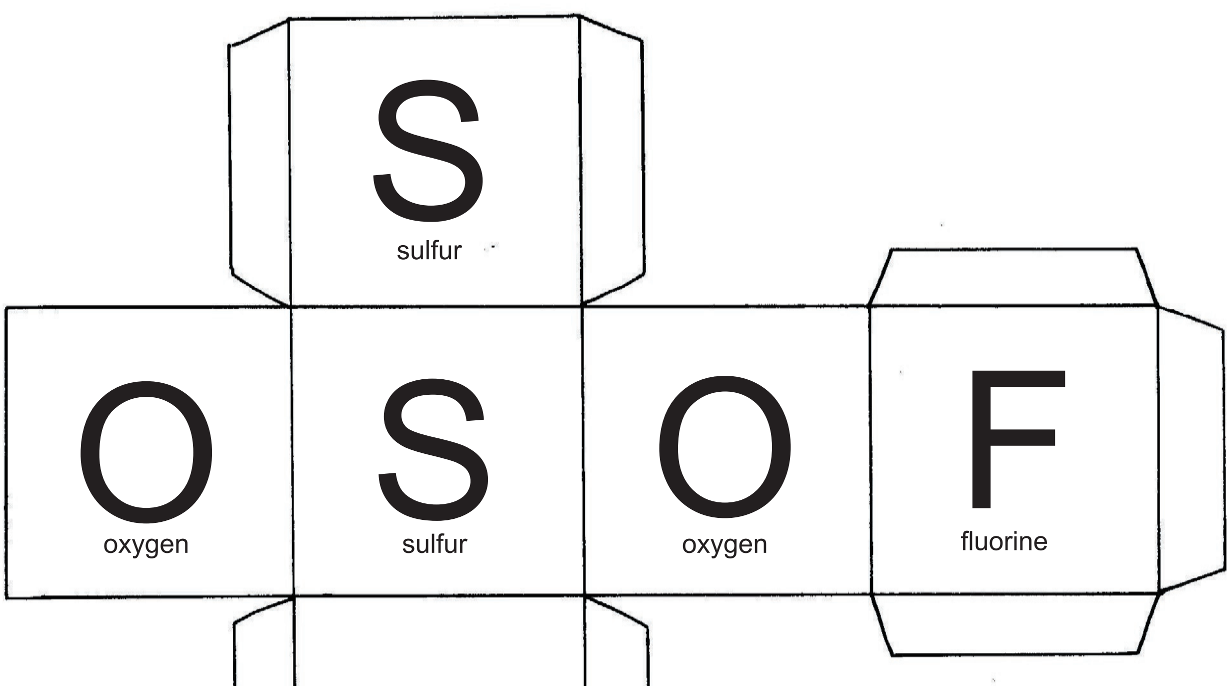
1) Cut out the dice patterns and make into cubes. (Or, you could use three blank wooden cubes and write the letters on each side. Any craft store that sells wooden parts will have wooden cubes. If you want to be able to store the game away in a cupboard without the dice being squashed, this would be the best option.)

2) Cut apart the 16 mineral cards.

How to play:

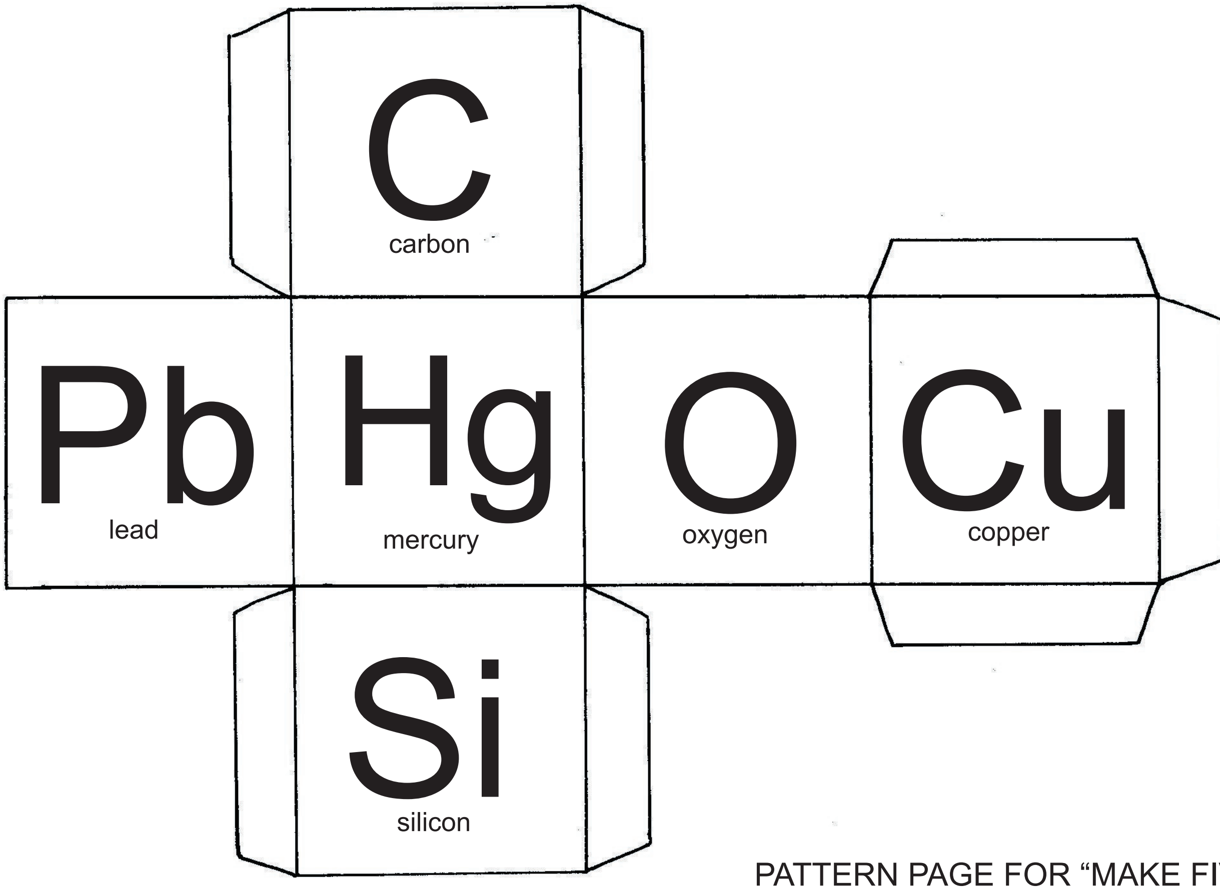
Place the mineral cards on the table, face up, so they form a 4 x 4 square. Each player will have a turn rolling all three dice at once. The goal is to roll the ingredients to form a mineral. (One roll of the three dice per player per turn.) For example, if the first player rolls: Cu, Fe, and S, he should notice that those are the ingredients of chalcopyrite. Therefore, that player picks up the chalcopyrite card. If the next player rolls Ca, C, and WILD, he could make the wild card into O, and be eligible to pick up calcite.

The first player to collect five cards wins the game.



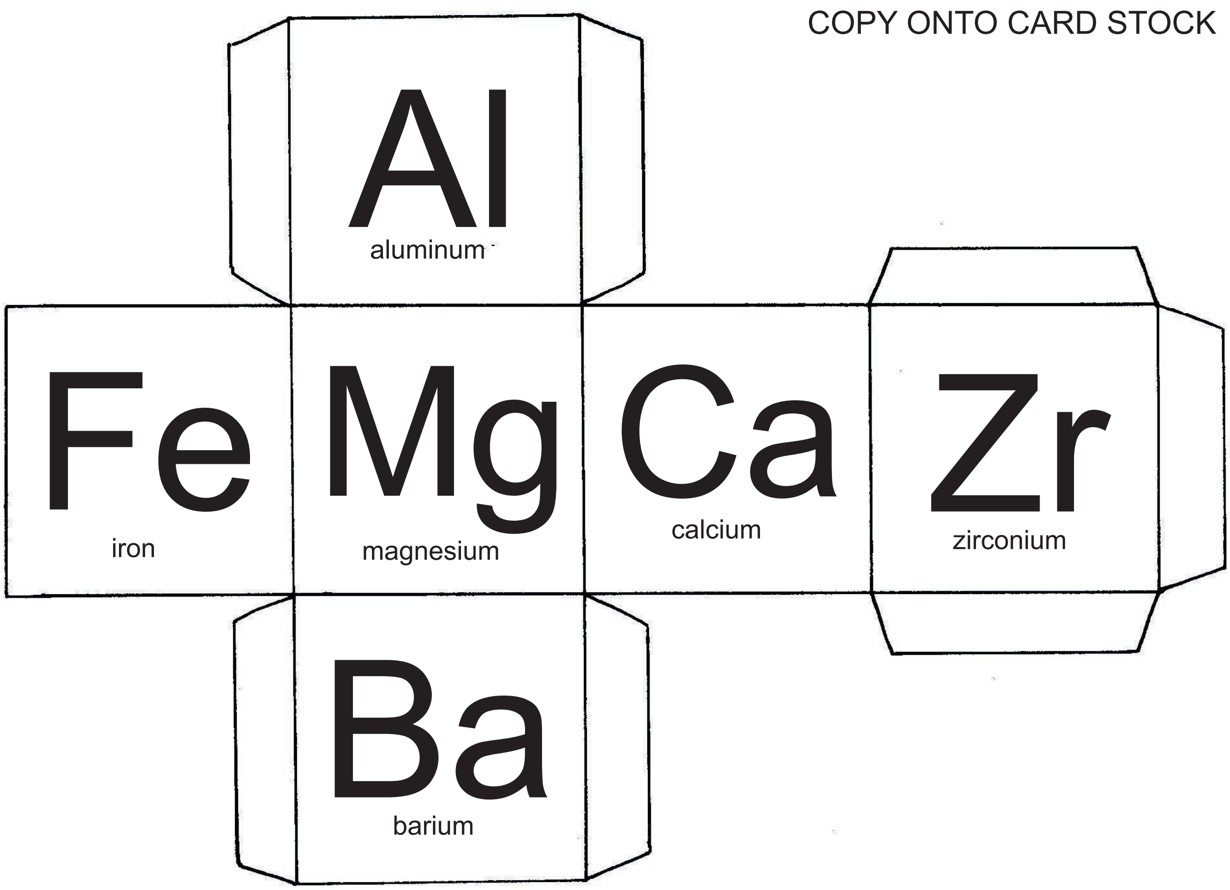
PATTERN PAGE FOR “MAKE FIVE”
(Die 1)

COPY ONTO CARD STOCK

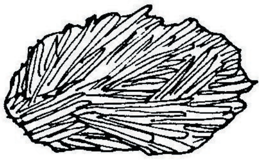


PATTERN PAGE FOR “MAKE FIVE”
(Dice 2 and 3)

COPY ONTO CARD STOCK



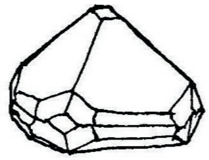
barite



$BaSO_4$

Often found in limestone or hot spring areas. Usually white or light brown. Sometimes crystalizes into rose shapes, which are popular with collectors.

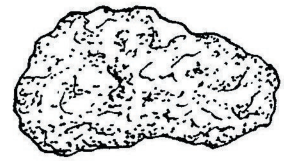
zircon



$ZrSiO_4$

Found in nearly all igneous rocks, although in very small amounts. Because it is so hard, it is often used as a gemstone in jewelry.

hematite



Fe_2O_3

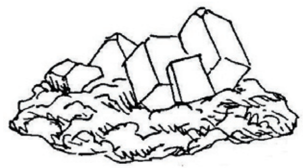
Hematite is a major ore (source) of iron. The name “hematite” comes from its blood-red color (“hema” means blood).

cinnabar

HgS

Cinnabar has a reddish color and is very dense (heavy) because of the mercury (Hg). Pure mercury is a liquid at room temperature, but it is a solid when bound to sulfur.

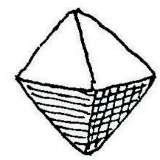
cuprite



Cu_2O

Cuprite forms cubic crystals. It is sometimes called “ruby copper” because of its color. When exposed to air it changes to CuO.

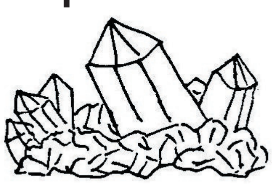
fluorite



CaF_2

Fluorite is used in the production of steel. It has a glassy luster and can look similar to a quartz crystal, except for its tetragonal (4-sided) shape.

quartz



SiO_2

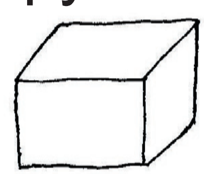
Quartz is used in electronics, as a gemstone, and in the manufacturing of glass (where it is the main component). Sand is made of very tiny pieces of quartz.

galena

PbS

Galena is very dense (heavy) because of the lead in it. During the era of musket rifles, galena was used as the source of lead to make musket balls.

pyrite



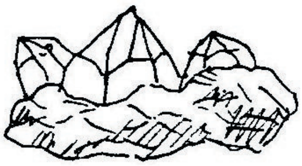
FeS_2

This mineral is often called “fool’s gold” because of its golden color and shiny luster. It has no actual gold in it. It leaves a black streak, not gold.

FIRST PATTERN PAGE FOR “MAKE FIVE”

COPY ONTO CARD STOCK

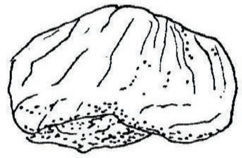
corundum



Al_2O_3

Corundum is very hard. It is so hard that it is used in industry as an abrasive (like sand paper). Blue corundum is called a sapphire and red is a ruby.

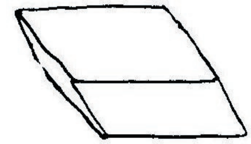
talc



$Mg_3Si_4O_{10}$

Talc is extremely soft. In fact, you can scratch it with your fingernail! Talc is the main ingredient in talcum powder (used to dry off after a shower).

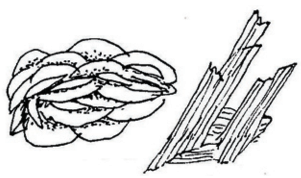
calcite



$CaCO_3$

Calcite is the main ingredient in limestone. It is one of the most common minerals in the world. Caves are made of limestone.

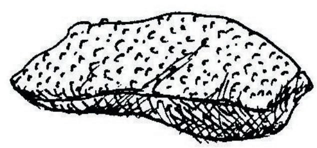
gypsum



$CaSO_4$

Gypsum is a soft mineral. It is one of the main ingredients in plaster and plasterboard. One type of gypsum is called alabaster and was carved by ancient peoples.

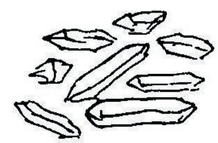
chalcopyrite



$CuFeS_2$

Chalcopyrite is pinkish-purple with flecks of gold. It is found wherever copper is mined. The copper can be taken out of it by using chemical processes.

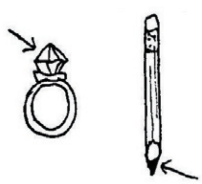
epsom salt



$MgSO_4$

This mineral dissolves into water very easily. It is often used in medical treatment of wounds on hands and feet. It helps in the healing process.

diamond/graphite



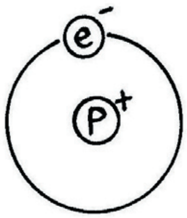
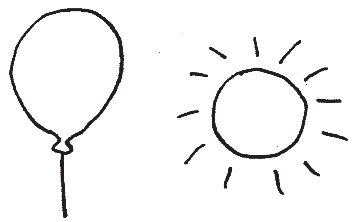
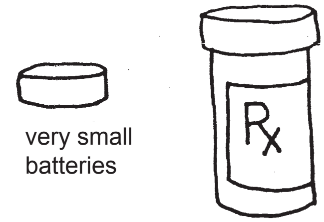
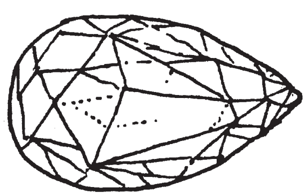
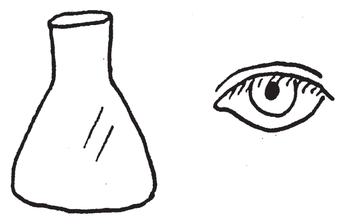
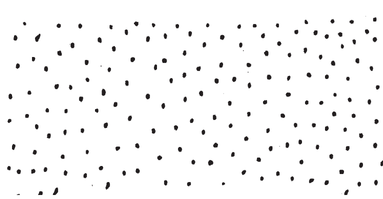
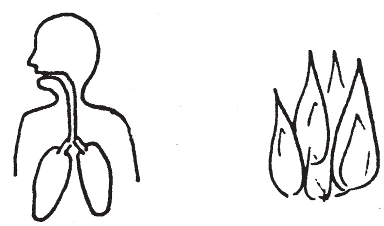
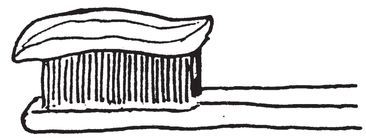
C

Strangely enough, both priceless diamonds and the stuff in your pencil are made of the same thing: pure carbon. The difference is how the atoms are bonded together.

SECOND PATTERN PAGE FOR “MAKE FIVE”

COPY ONTO CARD STOCK

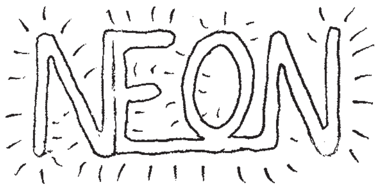
PATTERN PAGE FOR "SYMBOL JARS" COPY ONTO CARD STOCK

H **1** **Hydrogen** **1.0** *Greek: "hydro–gen" (water-maker)*  • Has no neutrons. • Most abundant element in the Universe. • Used in rocket fuel and fuel cells.	**He** **2** **Helium** **4.0** *Greek: "helios" (sun)*  • Used in balloons, blimps and scubing diving tanks. • Discovered in the sun in 1895 using a spectrometer.	**Li** **3** **Lithium** **6.9** *Greek: "lithos" (stone)*  • Used in batteries, lubricants, medicines, and nuclear bombs. • Is never found by itself in nature (it's always in a compound).
Be **4** **Beryllium** **9.0** *from the mineral "beryl"*  • Found in emeralds. • Is mixed with copper to make "beryllium bronze," an alloy that will not create sparks.	**B** **5** **Boron** **10.8** *from the compound "borax"*  • Used to make heat-resistant glass. • Used to make boric acid, which is used as an antiseptic eye wash. • Used in nuclear power plants.	**C** **6** **Carbon** **12.0** *Latin: "carbo" (charcoal)*  • Diamonds, graphite and coal are all made of carbon. • Carbon makes long chains (polymers) that are the basis of fossil fuels and plastics. • Carbon is necessary for organic molecules found in living organisms.
N **7** **Nitrogen** **14.0** *Greek: "nitron" (the mineral saltpetre)*  • Most of the air we breathe is nitrogen. • Used in air bags in cars. • Doctors use liquid nitrogen to treat skin conditions. • Proteins and DNA contain nitrogen.	**O** **8** **Oxygen** **15.9** *Greek: "oxy-gen" (acid-maker)*  • Found in air, water and sand. • Necessary for respiration and combustion. • Ozone is made of pure oxygen.	**F** **9** **Fluorine** **18.9** *Latin: "fluere" (to flow)*  • Found in the mineral fluorite. • Is put into toothpaste to fight cavities. • Used as a coolant. • Used in nuclear power plants.

Ne 10

Néon 20.1

Greek: “neo” (new)

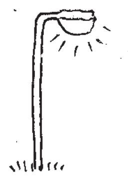


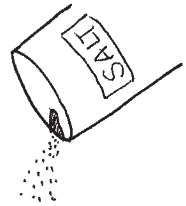
- Used in neon lights and lasers.
- Neon never bonds to any other elements.

Na 11

Sodium 22.9

from soda ash



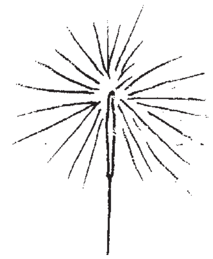


- Bonds with chlorine to make table salt.
- Used in street lights and in household cleaning products.
- Sodium is never found by itself in nature; it is always in a compound.

Mg 12

Magnesium 24.3

from Magnesia, in Greece

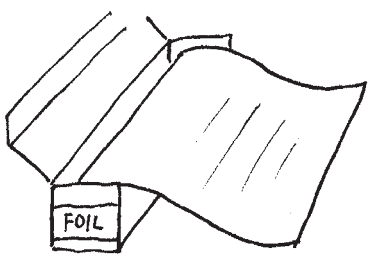


- Used in sparklers.
- Found in Epsom salts and “milk of Magnesia”
- Plants and animals need magnesium.

Al 13

Aluminum 26.9

from the compound “alumina”

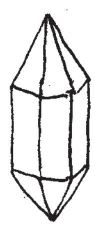


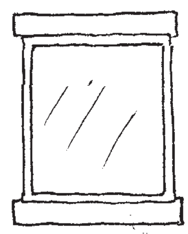
- Used in airplanes because it is so light and strong.
- Used for foil, tubes and cables.
- Used in fireworks.

Si 14

Silicon 28.0

Latin: “silex” (hard stone, boulder)



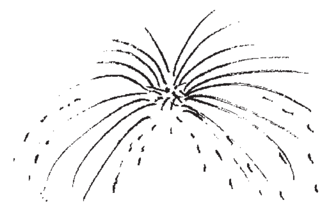


- Found in sand, clay, lava, glass and the mineral quartz.
- Used to make computer chips.

P 15

Phosphorus 30.9

Greek: “phosphoros” (bringer of light)



- Used in matches, fireworks, fertilizers and detergents.
- Discovered by an alchemist in 1669 as he was boiling down urine!

S 16

Sulfur 32.0

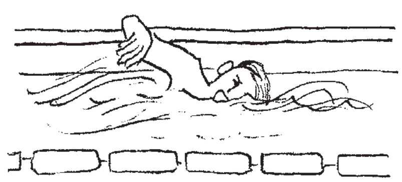
Latin: “sulfur” (stone that burns)

- Found in matches and fireworks.
- Used to vulcanize rubber.
- Volcanoes produce sulfur dioxide gas (a gas that’s also produced by some factories and forms a large part of air pollution).

Cl 17

Chlorine 35.4

Greek: “kloros” (light green)

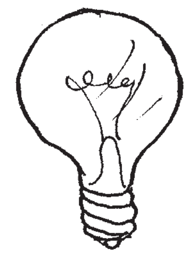


- Bonds with sodium to make table salt.
- Used to disinfect swimming pools.
- Is an ingredient in PVC plastics.
- Combines with hyrdogen to make HCl, an acid that your stomach produces to help with digestion.

Ar 18

Argon 39.9

Greek: “argos” (lazy)

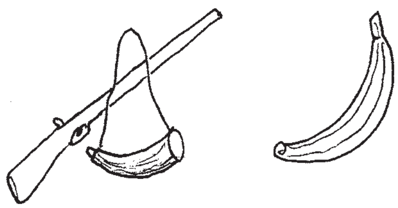


- Used in lightbulbs and lasers.
- Does not bond to, or react with, any other element.

K 19

Potassium 39.0

from the word "potash"

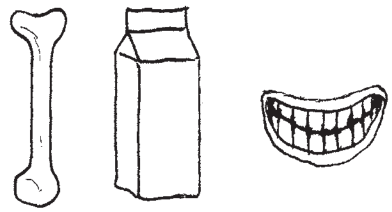


- Used in fertilizers.
- Is an ingredient in gun powder.
- Bananas contain a lot of potassium.
- Can form salts, just like sodium can.

Ca 20

Calcium 40.0

Latin: "calx" (chalk)

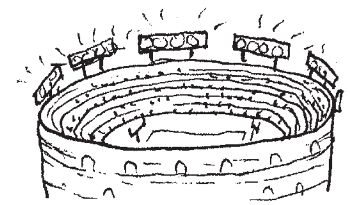


- Found in chalk, limestone, plaster, concrete, bones, and teeth.
- Milk contains a lot of calcium.
- Calcium in water makes it "hard."

Sc 21

Scandium 44.9

named after Scandinavia

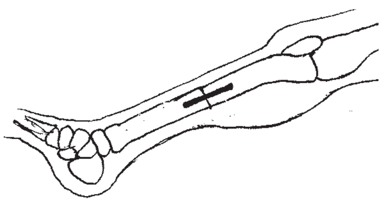


- Used in stadium lighting.
- Used in large television screens.
- Radioactive scandium is used as a "tracer" in petroleum refineries.

Ti 22

Titanium 47.9

named after the Greek Titan gods

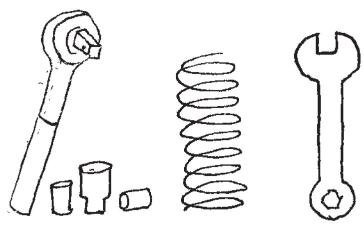


- Used to repair bones.
- Because it is lightweight it is used in airplane motors.
- Is an ingredient in paint pigments.

V 23

Vanadium 50.9

after the Scandinavian goddess Vanadis

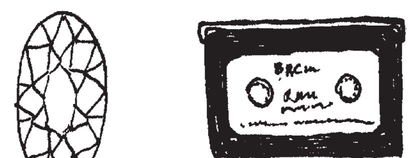


- Used in making steel.
- Is an ingredient in metals that are used to make tools, springs and engines.

Cr 24

Chromium 51.9

Greek: "chroma" (color)

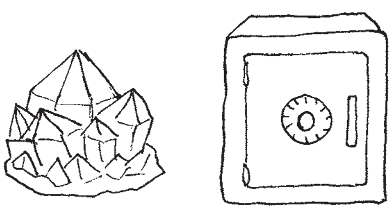


- Gives rubies their red color.
- Used to make red, green and yellow paint.
- Used as a shiny coating for metals.
- Used to make video tapes.

Mn 25

Manganese 54.9

Latin: "magnes" (magnetic)

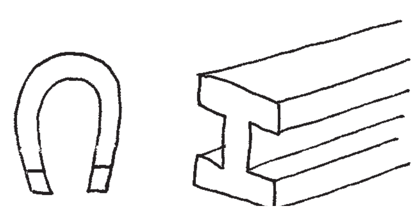


- Added to steel that needs to be very strong (for example: rifle barrels and bank vaults).
- Is necessary for the functioning of vitamin B1 in our bodies.

Fe 26

Iron 55.8

from Old English "iren"

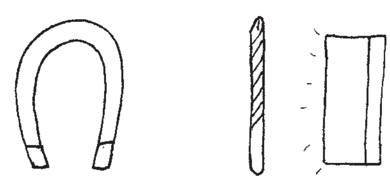


- Discovered in ancient times.
- Used in steel and in magnets.
- Found in red blood cells and in rust.
- Meteorites often contain iron.
- Red rocks usually contain iron.

Co 27

Cobalt 58.9

German "kobald" (evil gnomes)



- Miners used to say "kobald" lurked in the mines (and the name stuck).
- Used in "alnico" magnets.
- Used in making drill bits and razors.
- Can be used to color glass deep blue.

Ni 28

Nickel **58.7**

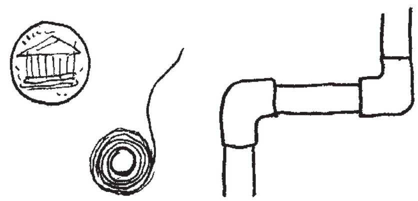
German: "Nickel" (Satan)

- Name comes from "Kupfernickel," meaning "Satan's copper."
- Used in the coloring of glass.
- Used to make coins and utensils.

Cu 29

Copper **63.5**

Latin: "Cuprum" (from Cyprus)

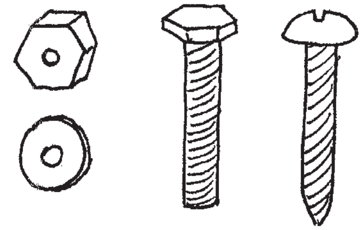


- Used for coins, wires and pipes.
- The Statue of Liberty is made of copper.
- Copper mixed with zinc makes brass.
- Copper mixed with tin makes bronze.

Zn 30

Zinc **65.4**

Greek: "zink"

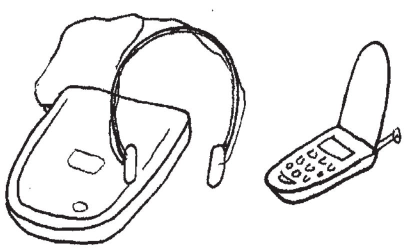


- Used for galvanizing (protecting) metals such as iron and steel.
- Zinc sulfide glows in the dark.
- Zinc oxide is used in photocopiers.

Ga 31

Gallium **69.7**

Latin: "Gallia" (France)



- Gallium arsenide is used in lasers and in compact disc players.
- Used in cell phones and in medical devices.

Ge 32

Germanium **72.6**

Latin: "Germania" (Germany)

semi-conductor

lens

- Is a semi-conductor and therefore is used in transitors.
- Used in lenses and fiberoptics.

As 33

Arsenic **74.9**

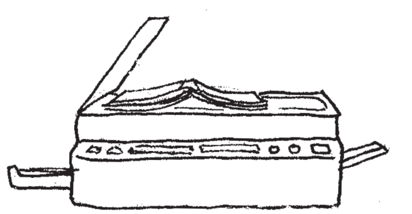
Latin: "arsenicum" (a pigment)

- Famous for its use as a poison.
- Is an ingredient in weed killers and insecticides.
- Used in lasers and LED's.

Se 34

Selenium **78.9**

Greek: "selene" (moon)

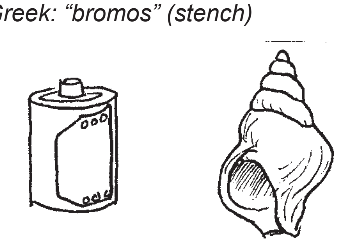


- Used in photocopiers because it conducts electricity in the presence of light.
- Used in robotics and in light meters.
- Selenium is beneficial to our bodies and acts as an anti-oxidant, protecting use from cellular damage.

Br 35

Bromine **79.9**

Greek: "bromos" (stench)

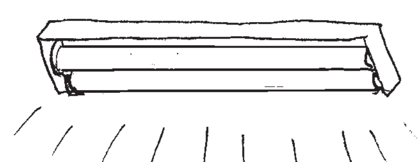


- Bromine is a reddish liquid with a very bad smell.
- Found in sea water and salt mines.
- Used in photographic film.

Kr 36

Krypton **83.8**

Greek: "kryptos" (hidden)

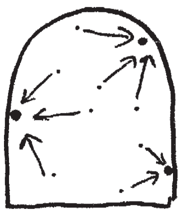


- Used in fluorescent flight, especially photographic bulbs.
- Used in UV lasers and in atomic clocks.

Rb 37

Rubidium **85.5**

Latin: "rubidus" (deep red)



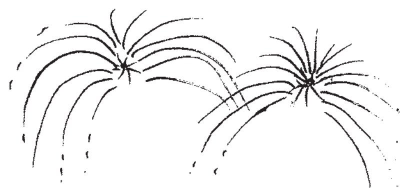
Rubidium captures atoms of gases that should not be in a vacuum jar or tube..

- Is a by-product of the refinement of lithium and cesium.
- Used as a gas "scavenger" (collector) in vacuum tubes.

Sr 38

Strontium **87.6**

after the Scottish village of Strontia

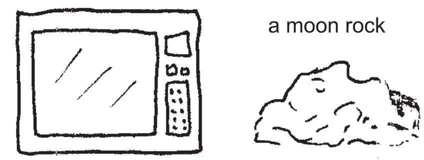


- Used in fireworks (bright red).
- Used in batteries in ocean buoys.
- Used to produce beta radiation.
- Used to research bone structure.

Y 39

Yttrium **88.9**

after the Swedish town of Ytterby

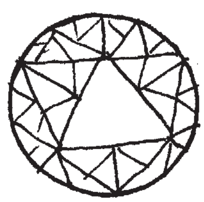


- Used in superconductors and lasers.
- Rocks from the moon contain yttrium.
- Used to make the bright red color in television screens.

Zr 40

Zirconium **91.2**

Arabic: "zargun" (gold color)

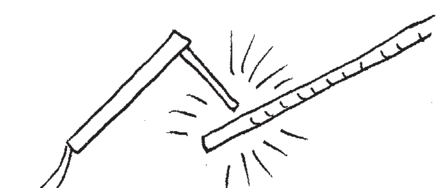


- Made into gemstones.
- Used in catalytic converters in cars.
- Used for heat-resistant parts in nuclear power plants and in space shuttles.

Nb 41

Niobium **92.9**

named after the Greek goddess Niobe



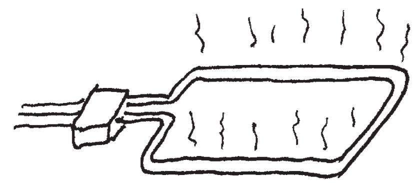
used in welding

- Used in welding rods, cutting tools, and superconducting magnets.
- Is added to steel to make it heat-resistant.

Mo 42

Molybdenum **95.9**

Greek: "molybdos" (lead)



- Used for filaments in heaters.
- is an ingredient in steel that is used to make engines for cars and planes.
- Large deposits of molybdenum are found in Colorado.

Tc 43

Technitium **99.0**

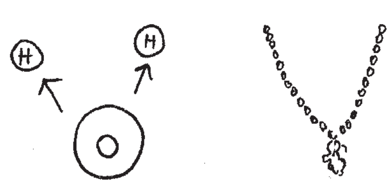
Greek: "teknetos" (artificial)

- Is radioactive.
- Not found in nature. Must be made in a nuclear laboratory.
- Is combined with other elements and used in medical procedures.

Ru 44

Ruthenium **101.1**

Latin: "Ruthenia" (Russia)

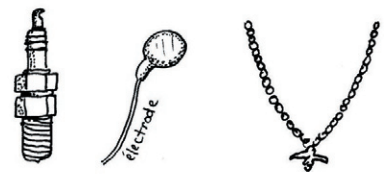


- Used to split water molecules.
- Used in the jewelry making industry.
- Often mixed with titanium and platinum to increase their hardness.

Rh 45

Rhodium **102.9**

Greek: "rhodon" (rose)



- Rhodium salts have a rose color.
- Used in catalytic converters in cars.
- Used in headlight reflectors.
- Used in jewelry to prevent tarnishing of sterling silver.
- Combined with **Pt** and **Pd** to make spark plugs, electrodes, and other electronic parts.

Pd 46

Palladium 106.4

named after the asteroid Pallas

- Used in dentistry and in jewelry.
- Used in catalytic converters in cars.
- Used to purify hydrogen gas.
- Used for treatment of tumors.

Ag 47

Silver 107.8

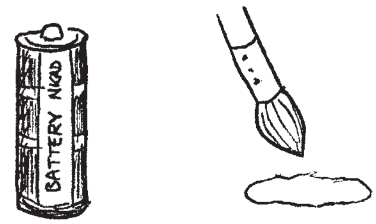
Anglo-Saxon: "soilful" (silver)
Symbol from Latin "argentum"

- Used to make coins, jewelry, mirrors, silverware, photographic film and electronic components.
- Sterling silver contains copper.

Cd 48

Cadmium 112.4

Greek: "kadmeia" (earth)

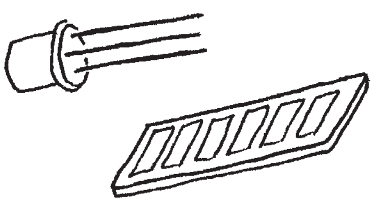


- Used in rechargeable batteries.
- Is a neutron-absorber in nuclear reactors.
- Used to make yellow and red pigments in paints.

In 49

Indium 114.8

Latin: "indicum" (indigo blue)

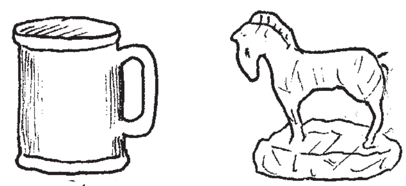


- Used in transistors and solar cells.
- Often mixed with other metals to make alloys.
- Its light wave pattern in a spectrometer shows bright purple lines.

Sn 50

Tin 118.7

Latin: "stannum" (tin)



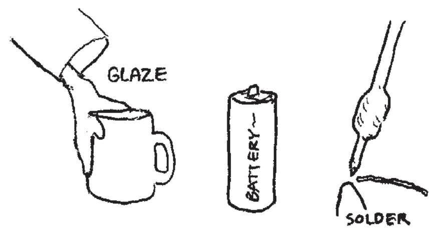
pewter bronze

- Is an ingredient of pewter.
- Is mixed with copper to make bronze.
- Turns into powder at low temperatures.

Sb 51

Antimony 121.7

Greek: "anti-monos" (not alone)
Symbol comes from "stibnium"



- Is also known by the name Stibnium.
- Used in ceramics, glazes, solder, lead batteries and matches.
- Increases hardness in alloys.

Te 52

Tellurium 127.6

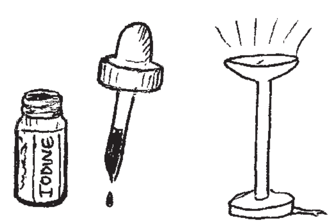
Latin: "tellus" (earth)

- Used to "vulcanize" rubber (although sulfur is the key ingredient in vulcanization)
- Is one of the few elements that will bond with gold.
- Used to color glass.
- Used in ceramics.

I 53

Iodine 126.9

Greek: "iodes" (violet)

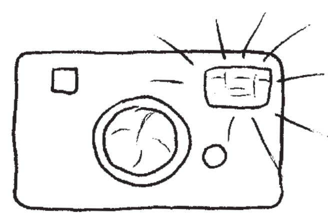


- Used as a disinfectant.
- Used in halogen lamps, ink pigments and photographic film.
- Our thyroid glands need iodine.

Xe 54

Xenon 131.3

Greek: "xenos" (strange)



- Used in camera flash bulbs, strobe lights, UV lamps and tanning bed lamps.

ACTIVITY IDEAS FOR CHAPTER 2

1) GROUP GAME: Play the element fishing game

Overview of game: This game can be played with multiple skill and age levels. The rules are constructed so that students who have no previous knowledge of the elements can play with those who do.

You will need: copies of the fish pattern page, printed onto heavy card stock if possible. You may use as few or as many of the elements in your game as you wish. Just copy enough fish for the number of elements you want to use.

You will also need: scissors, pencils or crayons, string, paperclips, little slips of paper (one per player), at least one pole of some kind (you can make as many fishing rods as you want to), at least one magnet (one magnet per pole), an area marked off to be the "pond"

Optional: You can use fish crackers at the end of the game. Have students trade in their paper fish for edible ones.

Set-up:

Cut out the paper fish. Have the students write the name of an element on one side of the fish and its symbol on the reverse side. NOTE: Make sure you use a writing implement that does not bleed through the paper. (Or you may want to have the fish pre-labeled before class.) If you want to make your fish durable, you could laminate them.

Put a paper clip on the nose of each fish. Make a fishing pole from a rod (even a yardstick will do) and a string, and put a magnet on the end of the string.

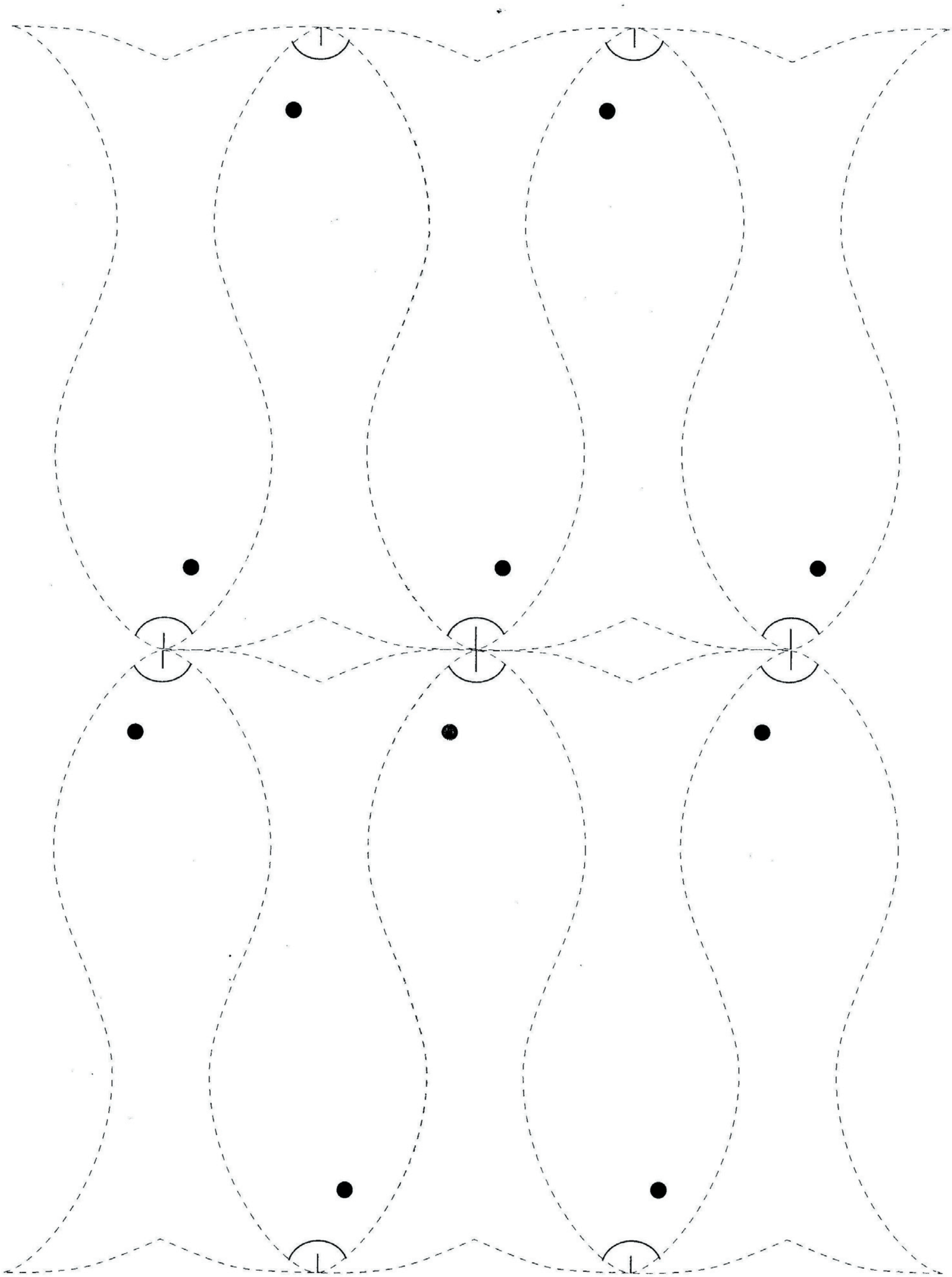
Mark off an area that will be the fishing pond. If you want to get fancy, you can use a plastic wading pool.

Each player needs a slip of paper with his or her name on it.

After the fish are made, put them into the pond so that either all the names or all the symbols are facing up. The game seems to be easier to play if the symbols are facing up. We've found that reading the name and guessing the symbol is a little more difficult.

How to play:

Each player must "call" the fish before he puts his rod in, by saying the name or letter on it. He must also choose one of two options: "guess" or "peek" If he chooses "guess" this means that he will try to say what is on the reverse side before he pulls the fish out of the pond. After guessing, he reels in the fish and looks on the back. If he is right, he keeps the fish; if not, the fish goes back in the water. The other option, "peek," is for when the player has no idea of the right answer and needs to learn it. The player still "calls" the fish, but then says "peek." After reeling in the fish, the player reads the reverse side out loud. After the "peek" option, the player may then put his name slip under the paper clip, before returning the fish to the pond. This reserves the fish for him until his next turn. No other player may catch his fish in the interim. On his next turn, that player will probably want to use the "guess" option, remembering what he read on the back of the fish last time. If he remembers correctly, he keeps the fish. If not, the fish goes back in the pond (with no name slip).



The game is over when all the fish are gone. You could play for a winner by counting up who has the most fish, or you can make the game non-competitive and simply give the players an edible reward for each fish they caught.

2) ACTIVE GROUP GAME: The Periodic Table Jump Rope Rhyme

You will need: jump ropes and track one on the CD that came with this curriculum

Note: You can have the students use individual ropes, or you can do it as a group activity with one long rope with a "turner" at each end. This second method is nice to start with because the turners and the players who are not jumping can be the ones to recite the elements while the jumper concentrates on jumping. We have found that it is not hard at all to elicit very loud group chanting as players jump! It's kind of natural to join in with a group chant.

You might want to start by just listening to the CD to catch on to how the chant goes. After a few times you can dispense with the CD and have the students do their own chanting. Once the students get the hang of the rhyme, stop using the CD. The game will be to see who can jump all the way to krypton without missing the rope. A player who misses the rope has to start back at hydrogen again (which is GREAT because that makes everyone review!!).

ACTIVITY IDEAS FOR CHAPTER 3

1) ACTIVE GROUP GAME: Human model of atom (a good outdoor activity!)

You will need: as many players as possible, and a large outdoor (or indoor) space.

How to play:

All players will represent electrons. The adult will represent the nucleus. Assign each player either a number (starting from one and going up as high as you have players) or an element (starting with hydrogen and going up as high as you have players).

Explain that this model will be a "solar system" model, with the electrons going in circles around the nucleus. Remind the players that both models (electron cloud and solar system) are valid and can be used at different times.

The adult will stand in the center of the playing area, and explain that he or she represents the nucleus. As the adult calls out the names of the elements, along with their atomic number, that player who has been assigned that element comes to join the atom. The first two players must run, without bumping into each other, in a fairly tight circle, not too far from the nucleus. The third player, when called, must start a new circle, farther out than the first one. Then players are added, one at a time, until the second ring has eight in it. If you have more players, start a third ring.

While players are being added, the ones already in the atom must keep going. We suggest assigning your most active students to represent the first electrons. They will be kept busy running in circles while other students wait to join.