Matter and the Atom

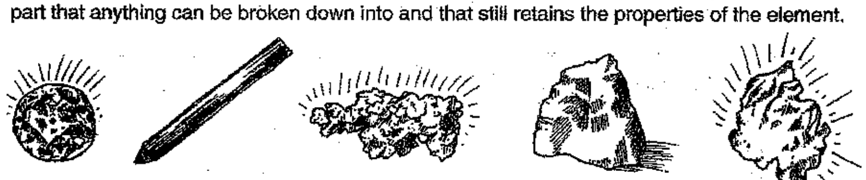
The atom is the smallest part of anything, and the universe is collectively the largest, yet both are closely related. Everything is made of matter, and all matter is made of atoms; this idea can present an interesting way of looking at everything in the universe.

So … what is an atom? Well … everything in our world is made of atoms, and this explains why atoms are called the building blocks of matter. These building blocks make up the air you breathe, the desk at which you are sitting, the paper and ink used in this book, and your body, which reacts to all of these things.

There are 94 (the latest count) naturally occurring kinds of atoms. **Naturally occurring** atoms are those not made in the laboratory. We are also able to create about 25 more atoms, which are referred to as **synthetic atoms.** All of this is well and good, but what does the atom look like? Again, this is an interesting question. Scientists are only able to give you their best guess, which has been changed many times and will continue to change as technology becomes increasingly more sophisticated.

To explain atoms, it is probably easier to start with the larger picture and work our way to the smallest. **Matter** is the term we use to explain anything that has mass and takes up space. If we were to look at air, we would find that 99.9% of the air is made of the elements nitrogen, oxygen, and argon. When we say that air is matter, we are referring to all of the elements. We can further break each of the three elements down to the billions and billions of atoms that make up the elements.

If you found this explanation somewhat helpful, let's try another example to cement the concept. An **atom** is the simplest form of matter that cannot be changed into a simpler form by ordinary means. An **element** is many of the same kind of atom. An example of this is when you have a piece of aluminum foil. This would be the element aluminum because it is many of the same kind of atom. If you tear a piece of aluminum from the roll and then keep tearing it into smaller and smaller pieces, you will eventually have a pile of aluminum specks that are good for nothing, but one could say that it is a pile of aluminum. The aluminum speck, while hardly visible to the human eye, contains millions and millions of aluminum atoms, each having the exact same properties of aluminum. Some of these properties include shiny, metal, solid at room temperature, and flexible as a thin sheet of aluminum. An atom, therefore, is the smallest part that anything can be broken down into and that still retains the properties of the element.



Diamond **Graphite** **Gold** **Sulfur** **Silver**
(both forms of carbon)

Name: ______________________ Date: ____________

Matter and the Atom: Reinforcement Activity

To the student observer: What is an atom? ______________________

____

Analyze: Why do we think of atoms as the building blocks of matter? ______________________

____

____

Directions: Complete the following activity.

1. How many naturally occurring atoms have been found? ____________
2. How many synthetic atoms have been created? ____________
3. What is the difference between a naturally occurring atom and a synthetic atom?

   ____

   ____
4. What is matter? ______________________

   ____
5. What is an element? ______________________

   ____
6. What is the difference between matter and elements? ______________________

   ____

   ____
7. What is the difference between elements and atoms? ______________________

   ____

   ____

The Parts of the Atom

There are three basic parts of the atom: **proton, neutron**, and **electron.** The protons and neutrons are located in the center of the atom; this area is called the **nucleus**. The electrons are found orbiting around the nucleus in an area we call the **electron cloud.** They are organized into levels within the electron cloud, and the outermost level is referred to as the **valence energy level**.

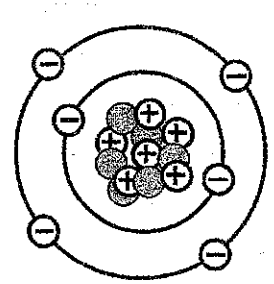
To understand the relative size of the atom, it is necessary to visualize something we already know something about. If the nucleus of the atom were about the size of a racket ball, the atom would have a diameter of more than 2 km. Another way to visualize the atom is to imagine that the nucleus is an ant crawling around at the centerline of a football field, and the first group of electrons would be circling 55 yards away (the end zones). Think of the distance between the ant and the end zones as empty space within the atom. Now shrink your relative thinking to the very, very small size of the atom. It now becomes much easier to think of the atom as really not much more than empty space. The actual atom is more than 99% empty space.

Let's take an in-depth look at each of these particles, the three basic parts of the atom: **proton, neutron**, and **electron**.

Particle	Charge	Location	Weight
proton	positive (+)	nucleus	1 amu
neutron	neutral (no charge)	nucleus	1 amu
electron	negative (-)	electron cloud	0.0018 amu

amu = atomic mass unit

If we were to look at a two-dimensional model of the atom, it might look like the following:



Notice the placement of the protons and neutrons together in the center of the drawing. This represents the nucleus.

The electrons will spin or orbit around the nucleus in a space called the electron cloud. There are many levels within the electron cloud.

The first level can hold up to 2 electrons and the second level can hold up to 8 electrons. The first level must be filled before beginning to fill the second level.

Name: ______________________ Date: ____________

The Parts of the Atom: Reinforcement Activity

To the student observer: What are the parts of the atom? ______________________

____

Analyze: Why do scientists use models of the atom when we know that they are not completely accurate?

____

____

Directions: Answer the following questions about the atom.

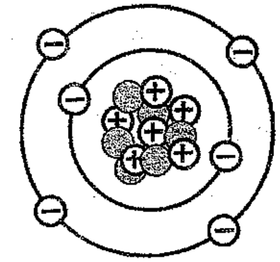
1. The atom can be divided into ____________ basic parts.
2. The three particles of the atom are the ____________, ____________ and ____________.
3. The protons and neutrons are located in the ____________.
4. The electrons are found in the ____________.
5. The electrons spin around or ____________ the nucleus.
6. The nucleus contains which atomic particles? ____________ and ____________
7. The electron cloud contains which atomic particles? ____________

What are the charges of the particles?

8. protons ________ 9. neutrons ________ 10. electrons ________

Look at the two-dimensional model of the atom. How many of each of the following do you find?

11. protons ____________
12. neutrons ____________
13. electrons ____________
14. What is the weight of the nucleus of this atom? ____________
15. An atom is very, very small. If you were to look at one atom through a microscope, what would take up most of the viewing area? ____________

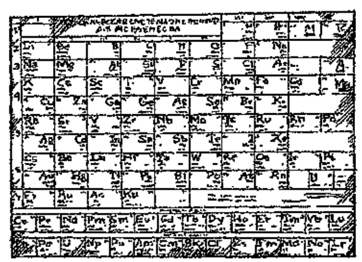


Atoms and the Periodic Table

Dmitri Mendeleev

A Russian physicist named Dmitri Mendeleev is credited with creating the Periodic Table of the Elements in the 1860s. Although many other scientists have made some important changes, the table allowed people to view the atoms in a pattern from smallest to largest and to recognize some common characteristics.

The modern Periodic Table is a table in which the elements are arranged in a pattern of increasing atomic number. Each line is read from left to right and starts over again when an energy level is full. There are many patterns to the Periodic Table. We will try to take it one step at a time with the goal of understanding and being able to use the information contained in the Periodic Table.



Example of the early periodic table of the elements

Let's start by reviewing the terms *atom* and *element*. Remember that an **atom** is the smallest particle of an element that has all the properties of that element. An **element** is made of two or more of the same kind of atom. So if I had mined a nugget of pure gold, I would have the element gold because all of the billions and billions of atoms making up the gold nugget are the atom gold. If I were able to look at just one gold atom under the world's most powerful electron microscope, I would see 79 protons. Gold is the only atom with 79 protons. If I counted 80 protons, I would have the atom mercury. Every proton looks the same; the number is what determines the atom. We know that gold and mercury are very different and yet very similar. Gold is yellowish in color and a solid at room temperature. Mercury, on the other hand, is silver in color and is the only metal that is a liquid at room temperature. The similarities are due to the fact that they are only one proton away from one another. They are both metals with heavy nuclei, are very shiny, and are very soft.

Most periodic tables give both the name of the element and the symbol used to represent the element. The symbols may be one, two, or three letters, and the first MUST be capitalized; if there is a second or third letter, they MUST be lowercase. The symbols used to represent the elements most often have a Latin origin, but some are also named for famous scientists.

Atoms and the Periodic Table (cont.)

Here are a few examples:

Element	Symbol	Name Origin
Carbon	C	Symbol from Latin: *carbo* (charcoal)
Copper	Cu	Symbol from Latin: *cuprum* (Island of Cyprus known for copper mines)
Mendelevium	Md	Named for Dmitri Mendeleev
Tungsten	W	Named from Swedish: *tung sten* (heavy stone) Symbol from German: tungsten is *wolfram*

The Periodic Table lists the elements according to increasing atomic number. Let's take a closer look at what this means. Hydrogen has one proton, so its atomic number is 1, while Helium has two protons, and its atomic number is 2. This is easy to understand, but when looking at the periodic table, we notice that they are on opposite sides of the table! We also see that Lithium has an atomic number of 3, which should position it next to Helium, but it appears as though Mendeleev decided to start a new line with Lithium ... so what's the deal? In order to understand these concepts, we need to discuss electrons and the electron cloud.

Do you recall the discussion of the fan blades representing the electron cloud, where they are spinning so fast that the path in which they are spinning becomes a blur? Well, let's slow the electrons down and look at the patterns they create. The first orbit closest to the nucleus is called the first energy level, and it can hold a maximum of two electrons. You must fill a level before moving out to the next energy level. The second energy level can hold a maximum of eight electrons. Energy levels 3 to 8 have differing numbers, so let's take a look at how to figure this out by looking at the periodic table. In some periodic tables, the electrons are shown in the electron distribution that shows you how the electrons are distributed in the electron cloud. In other periodic tables, there is no electron distribution listed, so you must look at the period. There are eight **periods**, and the energy levels are represented by period in the periodic table. A period is a horizontal row in the table.

Look at the periodic table. Period one represents the first energy level, which can hold up to two electrons. Now look at period 2. All of the elements in period 2 have electrons in two energy levels, and the second energy level can hold a maximum of eight electrons. If the element has more than 10 electrons (two in the first energy level + eight in the second), then you must start period 3 so that you have another energy level for the electrons. This placement of the elements continues throughout the table. We have learned enough for now, and it is time to do some practice.

Name: ______________________ Date: ______________

Atoms and the Periodic Table: Reinforcement Activity (cont.)

8. When you add the electrons in each energy level, the sum represents the total number of ____________, which is the same as the number of ____________ and the same as the ____________ ____________
9. Aluminum has electrons in how many energy levels? ________
10. Aluminum is in which period? ________
11. What does the period tell you? ______________________________

____

Complete the table below by using the information from the Periodic Table on the previous page.

Element	Symbol	Atomic Number	# of Protons	# of Electrons	# of Energy Levels	Period
Argon						
Carbon						
Helium						
Lithium						
Oxygen						
Sulfur						
Silicon						
Sodium						

Name: ______________________ Date: ______________

Atoms and the Periodic Table: Reinforcement Activity

We are going to practice what has been discussed here with just the first 18 elements, because they seem to follow the rules better than the other elements. Carbon is given here as a key to read the table.

Atomic Number: 6 — C Carbon — Electron Distribution: 2, 4

Period								
1	1 H Hydrogen (1)							2 He Helium (2)
2	3 Li Lithium (2, 1)	4 Be Beryllium (2, 2)	5 B Boron (2, 3)	6 C Carbon (2, 4)	7 N Nitrogen (2, 5)	8 O Oxygen (2, 6)	9 F Fluorine (2, 7)	10 Ne Neon (2, 8)
3	11 Na Sodium (2, 8, 1)	12 Mg Magnesium (2, 8, 2)	13 Al Aluminum (2, 8, 3)	14 Si Silicon (2, 8, 4)	15 P Phosphorus (2, 8, 5)	16 S Sulfur (2, 8, 6)	17 Cl Chlorine (2, 8, 7)	18 Ar Argon (2, 8, 8)

Directions: Complete the following activity.

1. What is the symbol for Aluminum? ________
2. What is the atomic number for Aluminum? ________
3. Aluminum has how many protons? ________
4. Aluminum has how many electrons? ________
5. What do you notice about the atomic number and the number of protons? ________

____

6. What do you notice about the number of protons and the number of electrons? ________

____

7. How many electrons does Aluminum have in the first energy level? ________