Scientific Notation and Atomic Structure

Finishing up Friday's Lecture and Starting to Look at Chemistry

Where Were We on Friday?

Recognizing Significant Figures

Number	Digits to count	Example	Number of Significant Digits
Nonzero digits	All	*8341*	4
Leading Zeros	None	0.000*79*	2
Captive zeros	All	*1200.00043*	9
Trailing Zeros	Only if decimal point	*400.0* and *4*00	4 and 1

What about Trailing Zeros before a decimal place?

For Example, 547,800,000 It has at least 4 Significant Figures but it may have more. Perhaps it has 5, or 6.

Maybe 7 or 8 or 9?

Scientific Notation

- To fix this we need a way to get rid of place holding zeros. That way all of the figures we see will be significant.
- Scientific notation is a way of writing numbers that does not need place holding zeros.

_._ _ _ _ _ x 10^{-}

For Example: 5.4789 x 10^{79}

Scientific Notation

We write the number with one digit to the left on the decimal point and use a power of 10 as the place holder.

3.2	3.2 x 1	3.2 x 10^0
32	3.2 x 10	3.2 x 10^1
320	3.2 x 100	3.2 x 10^2
320000	3.2 x 100000	3.2 x 10^5
320000000	3.2 x 100000000	3.2 x 10^8

Scientific Notation

When a number is greater than 1 the exponent is positive, if the number is less than 1, the exponent is negative

.58	$5.8/10 = 5.8/10^1$	5.8×10^{-1}
.058	$5.8/100 = 5.8/10^2$	5.8×10^{-2}
.0058	$5.8/1000 = 5.8/10^3$	5.8×10^{-3}
0.000058	$5.8/100000 = 5.8/10^5$	5.8×10^{-5}
.000000058	$5.8/100000000 = 5.8/10^8$	5.8×10^{-8}

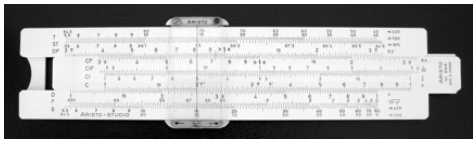
Expanded Significant Figure Table

Number	Digits to count	Example	Number of Significant Digits
Nonzero digits	All	*8341*	4
Leading Zeros	None	0.000*79*	2
Captive zeros	All	*1200.00043*	9
Trailing Zeros	Only if decimal point	*400.0* and *4*00	4 and 1
Scientific Notation	All	*3.7* X 10^3	2

The last one is true because one of the rules for writing numbers in scientific notation is that all significant figures, and no extra ones, are included.

Advantages of Scientific Notation

- No doubts about the number of significant figures.
- Easier to work with when dealing with a wide range of numbers.
- Essential when you use a slide ruler.



Significant Figures Conclusion

- In your answers you need to write your answer with the correct number of significant figures. Not too many. Not too few.
- Don't round early. Keep 2 significant figures too many until you write your answer.

For Example: A Density Calculation

I. Calculate the volume
32.981 ml
- 1.035 ml
31.946 ml

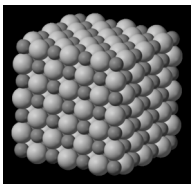
II. Calculate the Density using a mass of 12.21 g
Density=Mass/Volume
=12.21g/31.946 ml = 0.3822074 g/ml ?

Other Resources

- Lab this week.
- Discussion
- Video available on the Web
- Practice Significant Figure and Scientific Notation Problems online.

All matter is composed of atoms.

- Salt – Composed of 2 types of atoms arranged on a lattice

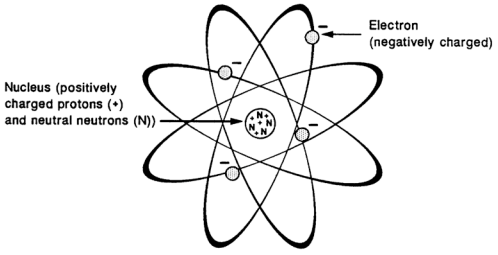


Atoms are pretty small. There are about 1000000000000000000, or 1 x 10^{18},atoms in a grain of salt

Atoms are small, but they are made of something smaller

- Protons-a subatomic particle with an electric charge of +1
- Neutrons-a subatomic particle without a charge
- Electrons-a subatomic particle with an electric charge of +1

Cartoon of an Atom



(This is a good diagram but it is conveying something that it would be hard to see if everything was drawn realistically and drawn to scale. What things do not seem right?)

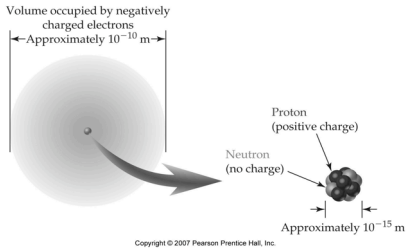
Masses and Charges of Subatomic Particles

TABLE 3.1 A Comparison of Subatomic Particles

NAME	SYMBOL	MASS (GRAMS)	MASS (AMU)	CHARGE (CHARGE UNITS)
Proton	p	$1.672\,622 \times 10^{-24}$	1.007 276	+1
Neutron	n	$1.674\,927 \times 10^{-24}$	1.008 665	0
Electron	e^-	$9.109\,328 \times 10^{-28}$	$5.485\,799 \times 10^{-4}$	−1

AMU = Atomic Mass Unit = 1/12 the mass of a carbon-12 atom. It can be thought of as an idealized mass of a proton or neutron.

How Much Room do They Need?



- In an atom the mass is due to what is in the nucleus and its volume is determined by the electrons that surround the nucleus.

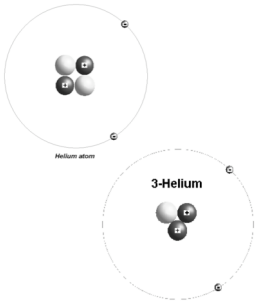
Elements

- Each element has a specific number of protons which is the same as its number of electrons.
- The element with the smallest number of electrons is Hydrogen. Hydrogen has only 1 proton and 1 electron.
- The largest is Ununoctium which has 118 protons and 118 electrons
- The electrons are the part that determine the chemical traits of an element, the number of protons and neutrons its mass.

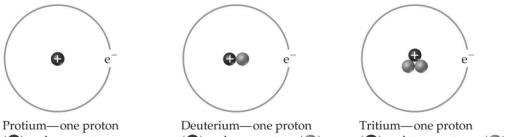
Helium-Isotopes

Helium has two electrons, two protons, and two neutrons, most of the time.

About 1 out of a million Helium atoms has 3 neutrons.



Isotopes of Hydrogen

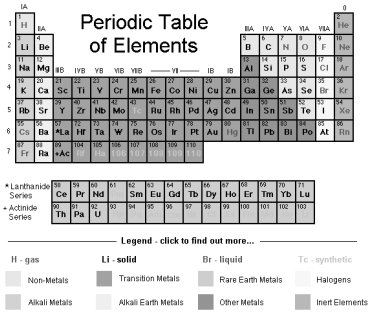


Protium—one proton (●) and no neutrons; mass number = 1

Deuterium—one proton (●) and one neutron (●); mass number = 2

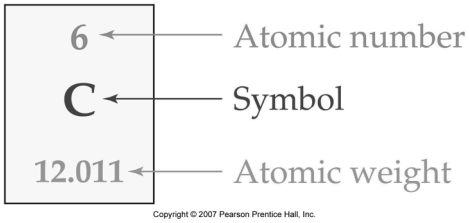
Tritium—one proton (●) and two neutrons (●); mass number = 3

Periodic Table of Elements

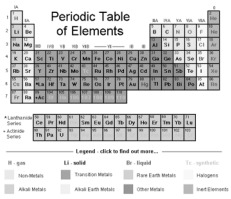


- Elements are ordered according the number of protons in the element. The atomic number of an element is the number of protons in that element and the number of electrons in a neutral atom of that element.

- The table has 114 boxes, each of which tells the symbol, atomic number, and atomic weight of an element.



Periodic Table

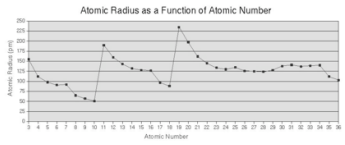


When arranged by atomic number similar elements can be found next to each other.

- Column of very non reactive elements is made on one end
- A column of very reactive metals is made at the other end
- A large number of similar metals are grouped in the middle
- And nonmetals are clustered in a small area

Properties of Atoms of the Elements

- Trends across and down the periodic table match with what is observations.



In Lecture we also viewed http://www.crystalmaker.com/support/tutorials/crystalmaker/resources/VFI_Atomic_Radii.jpg and http://www.webelements.com/_media/periodicity/tables/line/atomic_radius.gif

As atomic number increases so does atomic mass. (Since the number of neutrons in a stable atom is about the same as the number of protons.)

When the radius of