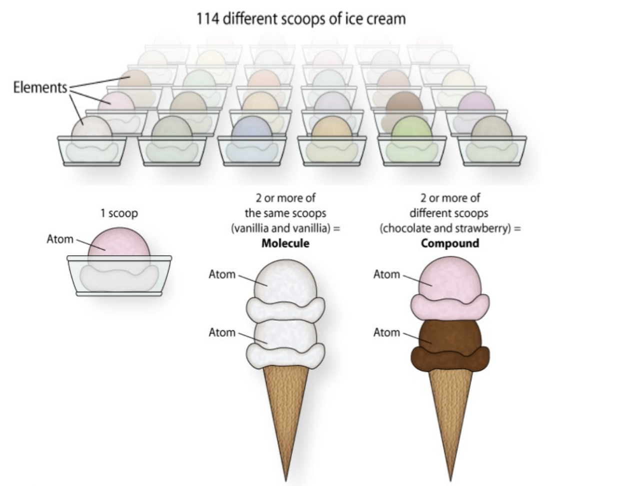
6.1 The Periodic Table of Elements

Learning Goals/Success Criteria: *At the end of this lesson, I will be able to:*

- ☐ Identity elements, compounds, molecules, mixtures and pure substances
- ☐ Describe the characteristic of neutrons, protons, and electrons
- ☐ Represent elements using Bohr-Rutherford Diagrams

Last chapter, we learned that ***mixtures*** comprise of ***more than one type of particle***, and could be divided into homogeneous mixtures (solutions) or heterogeneous (mechanical) mixtures. In contrast, ***pure substances*** are only made up of one type of particle, and can be further categorized into elements or compounds. ***Elements*** contain only one kind of atom and are found on the Periodic Table. You can combine these elements in different ways. ***Molecules*** are formed by two or more atoms. ***Compounds*** contain two or more types of atoms.

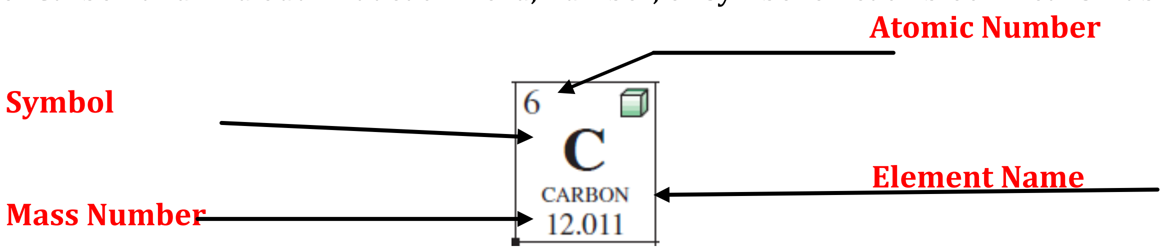
We can think of the Periodic Table as an ice cream shop with over 114 different flavours.



Atom: The smallest amount of ice cream you can order is 1 scoop, and there is no such thing as ½ scoop or ¾ scoop. A scoop is a scoop regardless of size! We see the same thing with atoms. You can only have whole-number amounts of atoms.

Elements: All the different flavours that are available at our ice-cream store are the different elements. Like the different flavours, each element consists of different ingredients that make it unique. Elements are the simplest pure substance made of only one type of atom.

All element symbols are either 1 letter or 2 letters. The first is a capital letter and the second is lowercase. There are a few cases where the element symbols have three letters. Look at the example below of Carbon and find out what each word, number, or symbol on each block means. Label them below:



1. **Most** element symbols are the first letter of the element name. Three examples are:
   1) Boron (B) 2) Oxygen (O) 3) Uranium (U)
2. Many elements **share the same first letter** in their name. So these element symbols have two letters that may remind you of some of the syllables in the element name. Three examples are:
   1) Be and Ba 2) He and Hf 3) Cu and Cd
3. Some elements have symbols based on their Latin names. Three examples are:
   1) Na 2) K 3) Ag

Molecule: Elements are the building blocks of all substances. If you order a double or triple scoop of ice cream, we start to build molecules. Molecules consist of 2 or more atoms and can be made of a single element (diatomic elements) or different elements (compound).

- Some elements always come in pairs. These elements are sometimes called the ***diatomic elements*** (di=two) because we have two atoms of the same element` or ***molecular elements*** because these elements exist as a molecule. This is like getting a double scoop of the same flavour. We get two hydrogen atoms (H) to make a hydrogen molecule (H_2).

H_2	hydrogen
O_2	oxygen
F_2	fluorine
Br_2	bromine
I_2	iodine
N_2	nitrogen
Cl_2	chlorine

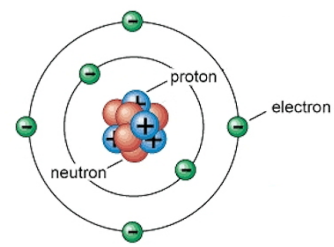
MEMORIZE THESE 7 ELEMENTS!

Do you know the HOFBrINCl twins?
Have no fear of ice cold beer
I have no bright or clever friends

- ***Compound***: When you order your double scoop, you might decided to get two different flavours. Here, two or more flavours (elements) gives us a new compound because the elements are chemically bonded together. All compounds are molecules because they consist of two or more different atoms.

6.7 Bohr-Rutherford Diagrams

Let's focus on the elements again. So far, we have looked at how the theory of the atom has evolved from:
Democritus → Dalton → Thomson → Rutherford → Bohr → Quantum Model
Even though our current understanding of the atom is the Quantum Model, simpler earlier models can still provide us with A LOT of information. The Bohr-Rutherford model of the atom combines Rutherford's planetary and Bohr's electron shell models to explain how the periodic table is organized and how compounds form.



The Bohr-Rutherford model consists of three ***subatomic particles*** with their own set of properties:

Name	Symbol	Relative Mass	Charge	Location
Proton	**p^+**	**1 amu**	**positive**	**nucleus**
Neutron	**n^0**	**1 amu**	**neutral**	**nucleus**
Electron	**e^-**	**0 amu**	**negative**	**electron shells**

Amu = atomic mass unit

What keeps the nucleus together?

- Neutrons have NO charge, so they do not attract or repel protons *due to electrostatic attraction (i.e. opposite charges attract)*.
- Neutrons and protons DO attract each other by a force called the "strong force"
- This is the strongest force in nature and overcomes the repulsion between positively charged protons *(i.e. like charges repel)*.

What keeps the electrons attracted to the nucleus?

- The nucleus has a positive charge, so it attracts the negatively charged electrons *due to electrostatic attraction (i.e. opposite charges attract)*.

- The electrons are not pulled into the nucleus because they can only be found in specific electron shells

Atomic Number (Z) = the number of protons in the nucleus of an atom

- It is the ID of a particular element. Ex: 6 protons = Atomic # 6 = Carbon
- No matter where that element is in the universe, it will always be carbon
- If the # of protons change, then it becomes a different element

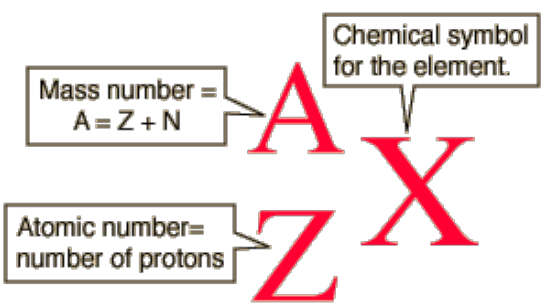
Mass Number (A) = Sum of the protons and the number of neutrons in an atom

- Protons and neutrons make up most of the mass of an atom since electrons are relatively small.
- Always a whole number → Round the mass numbers from your periodic table!
- Number of neutrons = Mass Number – Atomic Number

Calculating the Number of Subatomic Particles

Atomic Number (Z)	# of protons and # of electrons in a neutral atom
Mass Number (A)	# of protons + # of neutrons
# of Neutrons	Mass # – Atomic #
# of Protons	Atomic #
# of Electrons	Atomic # (in a neutral atom)

Standard Atomic Notation



Standard Atomic Notation	Atomic Number	Mass Number	# of p^+	# of n^0	# of e^-
$^{12}_{6}C$	6	12	6	6	6
$^{39}_{19}K$	19	39	19	20	19
$^{23}_{11}Na$	11	23	11	12	11

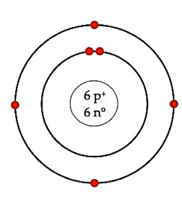
Drawing Bohr-Rutherford Diagram

- According to this model, electrons occupy specific ***energy levels*** or ***valence shells***
- Electrons in levels farther from the nucleus have ***more energy*** than electrons closer to the nucleus
- Only a certain # of electrons are allowed in each shell

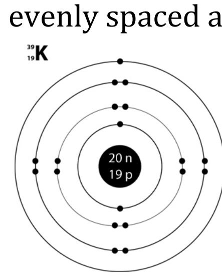
1. Draw a circle that represents the nucleus. Indicate the # of protons and neutrons in the circle. (Ex. $6p^+$, $6n^0$)
2. Determine the number of electrons in the atom. (Recall: # of electrons = # of protons = Atomic # for a neutral atom)
3. Determine how many energy levels or shells to draw around the nucleus. You can only move up to the next level after the previous level is filled. Draw electrons evenly spaced and pair up ONLY after 4 electrons have been placed.

Energy Level	Max # of e^-
1^{st}	2
2^{nd}	8
3^{rd} and beyond*	8*

*For Grade 9-11.



2, 4



2, 8, 8, 1