**Making Chemistry Your Friend**

Chemistry is a vast field of study in and of itself. In Biology, we use Chemistry as a tool to help us understand how things relate to each other on a smaller level. In this lab, we are going to take the aspects of Chemistry that relate to our studies so we can better understand the basics. Let’s start with the Periodic Table.

**The Periodic Table**

The Periodic Table of Elements is a list of all the know substances organized by their atomic number. Each element consists of protons (positively charged), electrons (negatively charged) and some have neutrons (neutral charge). The number of protons is unique to each element and determines its place on the table. Protons and neutrons are found in the center or nucleus of the atom and electrons travel around outside the center. The **Atomic Number** is the number of protons an element has, if that element has no charge, it will have the same number of electrons. Electrons have very little weight, but protons and neutrons have a weight that is larger. So,

**ATOMIC MASS = # of PROTONS + # of NEUTRONS**

Therefore, you can calculate the number of neutrons an element has by subtracting the atomic number from the atomic mass.

Let’s do some examples to be sure we understand. We’ve provided an abbreviated periodic table that lists the elements we use in biology. Use this table to fill out this data chart.

|  |  |  |  |
| --- | --- | --- | --- |
| **ELEMENT** | **ATOMIC MASS** | **ATOMIC NUMBER** | **NUMBER OF NEUTRONS** |
| **Na** |  |  |  |
| **Si** |  |  |  |
| **Al** |  |  |  |

Just to remind ourselves, the atomic number is also the number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**What are these elements anyway?**

There are a lot of symbols on this chart. You can find the atomic number and atomic mass of all the elements, but what do the letters mean? Using another source, fill in the names of all the elements underneath their atomic symbol. Two are done for you.

**What if there are a different number of Neutrons?**

Sometimes elements have a different number of neutrons than usual, so therefore have a different atomic mass. This is what we call an Isotope (a variant form of an element which has the same number of protons but a differing number of neutrons).

Sometimes we’ll see Isotopes labeled with their new mass like this:

14C = this is Carbon 14. Notice it has a different mass than what is on your periodic table

The average mass of all the isotopes is defined as an element’s **Atomic Weight**. Can you answer questions about these Isotopes?

|  |  |  |  |
| --- | --- | --- | --- |
| **ELEMENT** | **ATOMIC MASS** | **NUMBER OF PROTONS** | **NUMBER OF NEUTRONS** |
| 14C |  |  |  |
| 15N |  |  |  |
| 2H |  |  |  |

Use your table to look up the number of protons, remember that never changes!

Isotopes are used to help scientists find out how old things are by comparing how much of a certain isotope there is in the object. Think of it this way: at a party you have 1lb of cheese.  The half-life of cheese is 30 min.  How much cheese is left over when 30 min pass?  Well, you should have 0.5 lb left after 30 min, because that is the time needed to consume half the amount of cheese available.  How about in another half life cycle of cheese?  Well, in 30 min you lost 0.5 lb and have 0.5 lb left, so in the new cycle, you will lose half of that 0.5 lb sample or 0.25 lb and you are left with 0.25 lb of cheese.  How much time has elapsed? 1 hour.  And, wow, these people really like cheese.

Given this information, solve the following problem about isotopes:

Scientists have calculated that a particular piece of rock contained about 12 grams (g) of radioactive potassium-40 when it was formed. It now contains 3 g of potassium-40. The half-life of potassium-40 is 1.3 billion years. About how old is the rock?

**Why the Number of Electrons Matter**

Since we know each element as a defined number of protons, we can also use that number to determine the number of electrons, assuming the element has no charge. Let’s write some out.

|  |  |  |
| --- | --- | --- |
| **ELEMENT** | **NUMBER OF PROTONS** | **NUMBER OF ELECTRONS** |
| **C** |  |  |
| **O** |  |  |
| **Al** |  |  |
| **Na** |  |  |
| **Si** |  |  |

If we say that electrons travel around the nucleus of an atom in rings or shells, we can assign that ring a limit on how many electrons they can carry. We say that the ring that surrounds the nucleus has room for 2 electrons, then each ring after that has room for 8 electrons. The outer most ring is called the valence ring or valance shell and may or may not be full. Realistically, this might not be the most accurate way to diagramming electron distribution, but it helps us to see why they are where they are on the table and why they bond the way that they do. It also helps us establish the Group number at the top of each column

Let’s look at Carbon (C) – Given that C has an atomic number of 6:

How many protons does it have?

How many electrons does it have? C

How many are in the first ring? Second ring?

Using the C to the right, draw the electron distribution.

Using the same method, draw the number of electrons around each of these elements.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Na** | **H** | **N** | **Cl** | **O** | **Ne** |
| Sodium | Hydrogen | Nitrogen | Chloride | Oxygen | Neon |

What do you notice about the valence electrons of H and Na? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What column (Group) are those two elements in? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*See a trend? Let’s look at a few more*

What do you notice about the valence electrons of Cl? \_\_\_\_\_\_ N?\_\_\_\_\_\_\_

What column (Group) are those two elements in? Cl? \_\_\_\_\_\_ N?\_\_\_\_\_\_\_\_

What does the row tell you about how many shells you filled?

What do you think this means about Ne? Does it have room for more electrons?

Look at the other members of that group. What does that mean about their valence electrons?

**Why does the number of valence electrons matter?**

The number of electrons in the valence shell determines how an element will bond. If two elements share electrons to fill up their valance shells, they are called **covalent bonds**. If one element “steals” an electron from another element, those elements no longer have equal numbers of protons and electrons and this they are no longer equal, the element with have a charge. We call elements with charge ions. They are no attracted to each other because they have opposite charges; this is called an **ionic bond**.

We can give an educated guess as to whether an element is likely to bond covalently (share) or ionically (steal) based on where they are on the table. How you wonder? Well, let’s think about what the columns tell us about the number of valence electrons. If you are an element that is in Group II, you have 2 valence electrons. So you would need 6 to complete your shell. How likely is it that another element will share 6 electrons with you?

I think it’s more likely that the other element will steal 2 from you – which will make you an ion and more likely to bond ionically. What do you think?

Let’s look at the table and fill in the chart.

|  |  |  |  |
| --- | --- | --- | --- |
| **BOND TYPE** | **COLUMNS** | **SHARED/STEAL + or -** | **STRENGTH** |
| **Covalent** |  |  |  |
| **Ionic** |  |  |  |

**What about Hydrogen?**

In lecture, you probably also mentioned a third type of bonding called Hydrogen Bonding. Since Hydrogen (H) has one proton, it only has one electron. That means that Hydrogen can share or be stolen from depending on which element it’s reacting with. So, Hydrogen can do both!

Let’s define the three types of bonding using our textbook:

**Covalent –**

**Ionic -**

**Hydrogen -**