EXPERIMENT 4: Electron Configuration of elements

Material: laboratory display of the elements and a wall periodic table is required.

Objective: To learn the use of periodic table for writing electron configuration of elements.

INTRODUCTION

Basic building matter of all substances we see around us in this physical world is called **elements**. There are more than 109 different elements known today. The elements are composed of extremely small indivisible units called **atoms**. Around 2500 years ago A Greek scientist Democritus came up with this term atom for smallest indivisible particle. This word originates from Greek word Atoms which means that which cannot be split. He was 90% right. As we know that we can split the atom but then it becomes something else.

Elements can exist as solid liquid or gas form. Some elements occur in different forms, such as Carbon which exists as graphite and diamond. But whatever the form of the element, it is composed of its characteristic atoms.

In this experiment, you will be looking at some elements in the laboratory display. Some look different from each other, while others look similar. Elements can be categorized in several ways. In this experiment, you are going to group elements by similarities in their physical properties. Elements that appear shiny or lustrous are called **metals**. Metals are usually good conductors of heat and electricity, some may be very soft and can be cut with a knife like sodium and some may be hard like Iron. Most metals exist in solid form. Metals are ductile and malleable, that is they can be molded into shapes like wires sheet etc. You may observe that some metals have lost their metallic luster like magnesium. If you use a sand paper to clean it you might get a white powdery substance which is magnesium oxide formed by the reaction with oxygen in air. You will see that when you use a sand paper to remove the top layer fresh shiny metal is visible. Other elements called **nonmetals** are not good conductors of heat and electricity, may be solid liquid or gas, are brittle, and appear dull (not shiny).

Atoms are made of even smaller particles called **subatomic particles**. Three major subatomic particles we are primarily interested in are **protons (p)**, **neutrons (n)**, and **electrons (e)**. Protons are positively charged particles (+1), electrons are negatively charged particles (-1), and neutrons are neutral (charge = 0). Within the atom, the protons and neutrons are tightly packed together and are at the center of atom called **nucleus. Protons and neutrons are** called "nucleons." Most of the atom is empty space occupied by electrons moving in circular path around the nucleus

Electrons are much smaller that nucleons and their mass is almost negligible compared to the mass of the protons and neutrons in the nucleus.
All atoms of a particular element have one feature in common: the number of protons in the nucleus. The number of protons, called the **atomic number** is unique for each element much like your ID number. Atoms of the element hydrogen always have one proton in their nuclei, while atoms of the next element, helium, always

have two protons in their nuclei. Atoms of the element Nitrogen have seven protons and that of Sodium have 11 protons.

The sum of the number of protons and neutrons in the nucleus of an atom is called the **mass number** of the atom.

Mass Number = Number of Protons + Number of Neutrons

Protons attract the electrons because they have opposite charges. *In a neutral atom, the number of protons is equal to the number of electrons*. This is the normal situation in atoms. However, through chemical reactions, an imbalance in the number of protons and electrons can result. For example, when the element sodium ($11p^+$, $11e^-$) reacts with the element chlorine ($17p^+$, $17e^-$) the compound sodium chloride, NaCl, is formed. Sodium chloride is an *ionic* compound composed of sodium *ions*, Na^+, with +1charges, and an equal number of chloride ions, Cl^- with –1 charges. In the reaction, each sodium atom *loses* one electron and each chlorine atom *gains* one electron, so the number of protons and electrons are now $11p^+$, $10e^-$ in the Na^+ ion and $17p^+$, $18e^-$ in the Cl^- ion. All atoms of the same element have the same number of protons and electrons, but they often differ in the number of neutrons. This means that atoms of the same element have same atomic number but can have different mass numbers. The atoms of an element that have different numbers of neutrons are called **isotopes** of that element. In the **complete chemical symbol** or **symbolic notation** of an element, the mass number and atomic number are indicated next to the symbol.

For example, the isotope of the element Carbon that has 8 neutrons has the following symbol:

$$^{14}_{6}C$$

The number of protons in an atom is given by the atomic number. To determine the number of *neutrons*, the *mass number* of the atom is needed. The number of neutrons is determined by subtracting the atomic number from the mass number.

The Periodic Table

The periodic table is a listing, in chart form, of the known elements. It has gone through many revisions and sometimes appears in alternate forms, but with the discovery of atomic numbers in the early 20th century, this has been the basis for the order of the elements in the table. But even before this time, it was long recognized that certain elements shared similar properties, and when the property, such as density, was plotted against atomic mass, a repeating, or "periodic" pattern was observed. Beginning with Dmitri Mendeleev in 1869, chemists began organizing the elements in rows and columns in an attempt to explain the periodic nature of various physical and chemical properties of the elements. Below is shown a modern periodic table:
The modern periodic table is arranged in horizontal **rows** (also called **periods**) and vertical columns called **groups** or **families**. The rows are numbered from 1 to 7. The groups have not always been numbered consistently, but are usually numbered 1A, 2A, 3A, etc., from left to right, excluding the groups of the *transition* elements in the middle, which have a different numbering. Because of this confusion, most modern tables have the groups numbered 1 through 18, excluding the lower, separate rows of elements (the *lanthanides* and *actinides*) below the main table.

Below is a table with the common names of different sections and columns given.

The **alkali metals**, found in Group 1 (or 1A) of the periodic table are very reactive metals and as such do not occur freely in nature. They are the elements Li, Na, K, Rb, Cs, and Fr. Will from ions with a charge of +1.

The **alkaline earth** elements are metallic elements found in the second group of the periodic table. They are not as reactive as the alkali metals, but are so reactive that they are likewise never found free in nature. These are the elements Be, Mg, Ca, Sr, Ba, and Ra. Will form an ion with a charge of +2

The elements of Group 17 (7A) are called the **halogens**, which mean "salt formers." These are the elements F, Cl, Br, I, and At. Fluorine and chlorine are gases. Bromine is a brown liquid and Iodine is a purple solid. Will from ions with charge of -1.

The **noble gases** are found in group 18 or VIII A of the periodic table. These elements were considered to be chemically inert until the 1960's when their first compounds were characterized. The **representative elements** occur in Groups 1-2 and 13-18or IA to VIII A. and exclude the transition metals and inner transition metals.

The term "**transition elements**" most commonly refers to the "d-block" elements in which the d electronic sublevel is being filled with electrons. The "**inner transition elements**" are the "f-block" elements in which the f-sublevel is being filled with electrons. The inner transition metals are further divided into the **lanthanide** series and the **actinide** series. They are normally separated from the rest of the elements in the periodic table.

Experimental Procedure

For this experiment a laboratory display of the elements and a wall periodic table is required.

Part A. Predicting Properties based on the Periodic Table

Use the location of the given elements in the periodic table to predict whether the elements listed would be a metal or non-metal and shiny or dull. After you have completed your predictions, observe those same elements displayed to determine if you predicted their properties correctly.

Part B. Comparison of Physical Properties of Elements

Complete the table in the report form by writing the Symbol and atomic number for each element. Observe the elements in the laboratory display. Describe their properties (color and luster). From your observations, describe each type of element as a metal or a non-metal.

Part C. Subatomic Particles and Chemical Symbols

Complete the table given in the report form with the correct atomic numbers, mass numbers, and number of protons, electrons, and neutrons for the neutral atom of each element.

Part D. writing the electron configuration

Write the long hand and short hand (core) electron configuration for the elements you observed.

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REPORT SHEET

Name ______________________________

Instructor ___________________________

Date _______________________________

Part A and B

Write the symbol, Atomic Number, Color Shiny/Dull, Metal/Nonmetal

Element	Symbol	Atomic number	Metal or nonmetal	Dull or shiny expected and observed
Zinc				
Aluminum				
Carbon				
Iodine				
Sulfur				
Copper				
Calcium				
Iron				
Tin				
Oxygen				
Magnesium				

Part C

Element atomic number, mass number symbolic notation and Number Protons Electrons Neutrons

Element	**Mass number**	**# of proton**	**# of electron**	**# of neutron**	**Symbolic notation**
Zinc					
Aluminum					
Carbon					
Iodine					
Sulfur					
Copper					
Calcium					
Iron					
Tin					
Oxygen					
Magnesium					

Part D

Element	Long hand configuration	Short hand configuration
Zinc		
Aluminum		
Carbon		
Iodine		
Sulfur		
Copper		
Calcium		
Iron		
Tin		
Oxygen		
Bromine		

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Name:___________________________

Pre-Laboratory Questions and Exercises

Due before lab begins. Answer in the space provided.

1. Define the following terms:

a) Isotopes

b) Subatomic particle and their location

2. Compare the physical properties of metals and nonmetals (at least four properties).

3. Use the periodic table to categorize the following elements as metals (M) or nonmetals (NM).

Cl…….. S…….. Cr …….. Ni …….. Ba…….. I ……..

4. A neutral atom has a mass number of 58 and contains 30 neutrons. Write its complete chemical symbol (showing the mass number and atomic number).

5. Determine the number of protons, electrons, and neutrons in the following atoms:

a) Aluminum-27

b) Bromine-80

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Name:____________________________

Post-Laboratory Questions and Exercises

Due with lab report. Answer in the space provided.

1. What kind of elements will form an ionic compound?

2. In an ionic compound the charge on metal ion is ______ and nonmetal ion is _______.

3. What kind of ions are likely to form from following elements and how.

   a. Calcium

   b. Bromine

   c. Aluminum

   d. Potassium

   e. Oxygen

4. Label as ionic or covalent and name them.

   a. NaBr

   b. Fe_3N_2

   c. PCl_3

   d. $NaNO_3$

   e. CBr_4