ELEMENTS AND THE PERIODIC TABLE

Textbook Reference: **Section 5.5 page 184 – 189**

History of the Periodic Table:

The periodic table was invented by D. Mendeleev and some corrections were later made by Mosely.

In its present form the elements are placed as a function of the atomic number.

Some elements were named after people, while other elements were named after planets. Some elements were named as a function of the peculiar properties or even named for a colour. Hydrogen was named for the fact that it produces water when it is burned.

Assignment:

With the help of a dictionary, name the **six elements** by deduction, from the following statements:
(1) A geographic location, (2) a heavenly body, (3) a scientist, (4) mythology, (5) a colour, (6) some remarkable property

A modern Periodic Table usually shows the atomic number along with the element symbol: $^{\text{At. Mass}}_{\text{At. No.}}\text{X}$

Atomic number indicates the number of electrons in the atoms of an element.

The periodic table is arranged in increasing order of atomic number or proton number.

Electron configuration of elements helps to explain the recurrence of physical and chemical properties.

Thus, the general properties and trends within a group or a period may be predicted with considerable accuracy for an element.

Terminology

Period :

Group (or Family):

Four Groups, (or Families) are given common names:

Group Number	**Common Name**
Group 1 (1A)	
Group 2 (II A)	
Group 17 (VII B)	
Group 18 (VIII)	

In the space below: Sketch and label the Periodic Table with the above Groups.

Further Classification : Elements are divided into metals and non-metals.

State the properties of each:

Metals **Non - Metals**

The classification of elements into metals and non-metals is not absolute.

Certain elements, (**boron, silicon, germanium, arsenic, antimony, tellurium, polonium, astatine**), are in a peculiar situation.

Why?

What do we call this category of elements?

Metalloids : Border the Zindle Line, (a Zigzag line or step-line), resemble metals, however, in chemical behaviour and in properties of their compounds they are more like the non- metals.

Only 17 of all elements are non-metals, all but five are gases: $C_{(s)}$, $P_{4(s)}$, $S_{8(s)}$, $Br_{2(l)}$, $I_{2(s)}$

Definitions

ATOM

–the smallest unit of an element, made of many particles, the most important are protons, neutrons and electrons,

— protons and neutrons in the central nucleus, electrons in the outer regions,

– atoms have no net charge, because:

the number of protons = the number of electrons

(+) (–)

NUCLEUS

-central, massive, positively charged core of the atom: contains the neutrons and protons of the atom

ELECTRON

–very small particle located in the outer region of an atom,

--each electron has a charge of –1

-each electron has a mass about 2000 times smaller than that of a proton or a neutron

-it is the loss or gain of electrons which makes uncharged atoms into charged ions

What is a positively charged ion called? _____

What is a negatively charged ion called? _____

Chemical properties depend on certain particles.

Which particle is it? _____

Within the atoms, only a few of the particles determine the chemical properties.
Where are these situated? _____

One type of particle, situated in a particular place in the atom, is related to the Group Number of the element.
Which particle and what is its location? _____
What is the meaning of the Group Numbers? _____

If the electrons of the valence shell of different elements are _____, then the elements are part of the same _____, (family).

For any given element, the valence number of electrons is equal to the _____ _____, located at the top of each _____ of the periodic table.

The _____ _____ are the electrons making up the last or outside layer of an atom.

The _____ electrons are all the other electrons in the atom.

PROTON
-each proton has a charge of +1 and a mass about equal to a neutron, located in the nucleus of the atom

NEUTRON
-uncharged particles located in the nucleus of the atom, has about the same mass as a proton
-atoms of the same element may have different numbers of neutrons (such atoms are said to be isotopes)

Atoms of the same element having the _____ atomic number, but a _____ atomic mass are said to be _____.

Sketch an atom of sodium, $^{23}_{11}Na$, and label the following:
protons, neutrons, core electrons and valence electrons.

Fill the following table:

Particle	Location	Mass	Charge
Proton			
Neutron			
Electron			

ION
-atom which has either lost or gained electrons and therefore has either a net negative or a net positive charge (i.e. loss of electrons produces _____ charged ions and gain of electrons produces _____ charged ions.)
Positive ions are called _____, whilst, **negative ion are called _____.**

ATOMIC NUMBER
-the number of protons in the nucleus of an atom (because atoms are uncharged, the atomic number will also tell you how many electrons are present in the atom)
-is characteristic of an element (i.e. each element can be identified by its own atomic number)

State the number of electrons, the number of protons and the number of neutrons for the following elements:

	$^{23}_{11}Na$	$^{35}_{17}Cl$	$^{16}_{8}O$	$^{40}_{19}K$	$^{31}_{15}P$	$^{37}_{17}Cl$
# e^-						
# p^+						
# n^0						

State which two species are isotopes. _____

MASS NUMBER
-the total number of protons (i.e. the atomic number) and neutrons in the nucleus.
-the atomic mass of an atom is essentially determined by its nucleus.
— Just add the number of protons and neutrons. [The mass of the electrons is considered negligible.]

Atomic Mass = # p^{+1} + # n^0

Atomic Mass = Atomic Number + # n^0

We will assume that the protons and neutrons each have a mass unit of one (1 amu).

With this condition, the nucleus has a whole number of particles, and the mass of each atom is the integer part of the atomic mass.

The carbon atom has been chosen as the standard for determining the atomic mass of the elements. (It replaced hydrogen as the standard, because so many compounds have carbon as one of the elements -- organic chemistry.)

Atomic mass is the mass assigned to an atom relating its mass to one who's mass has arbitrarily been assigned a value of 12 units (^{12} carbon). This element of reference is Carbon – 12

Mass Number can vary with different isotopes of the same element**.**
The following is a silhouette representation of an element on the periodic table:

$$^{A}_{Z}X$$

X: represents the chemical symbol for the element.
A: is the mass number and
Z: is the atomic number.

ISOTOPE

-although different atoms of the same element will always have the same number of protons (i.e. the same atomic number), they may have slightly different numbers of neutrons (making their mass numbers different). Such atoms are known as isotopes.

Isotopes contain the **same number of protons,** (this is what makes the atoms the same element, i.e. the same atomic number), but they have **different number of neutrons**, (this makes them isotopes of the same element, i.e. different mass number).

Isotopes have different number of nucleons.

Number of nucleons = # protons + # neutrons = mass number

Number of neutrons = Mass number − atomic number

In nature, the concentration of isotopes of an element is very unequal.

The relative abundance of each isotope in the same element is referred to as the Isotopic Composition.

Isotopes are often simply listed with identifying mass numbers (their atomic numbers are all the same).

Example: Three common isotopic composition of lead are lead-206, lead-207 and lead-208.

For each isotope of lead, (symbol ___):

	^{206}Pb	^{207}Pb	^{208}Pb
the number of protons	_____	_____	_____
the number of electrons	_____	_____	_____
the number of neutrons	_____	_____	_____

Assignment

1. What is the atomic mass of carbon 12? _____

2. What is the atomic mass of natural carbon that is written in the periodic table? _____

3. Why is the atomic mass of carbon not expressed as a whole number? _____.

4. Each natural element is a mixture of isotopes.

a) what do we call the relative abundance of each isotope in the same element? _____ _____.

b) For any given element, what can be said of the concentration of the isotopes? _____.

c) Write the # e^{-1}, # p^{+1}, and the # n^0 for:

^{12}C ^{14}C

5. Make a Table with the following headers, for the first 20 elements of the Periodic Table:

Element Symbol Atomic Number Atomic Mass # e^{-1} # p^{+1} # n^0

6. Make another table, using the same headers, as the above table, with the following species:

a) Na^{+1} (b) Ca^{+2} (c) Al^{+3} (d) F^{-1} (e) O^{-2} (g) S^{-2} (h) P^{-3} (i) Cl^{-1}

Chemical Properties and the Periodic table

When chemical reaction occurs, compounds formed as atoms attempt to take on the valence electron configuration of the closest inert or noble gas, (eight electrons except for Helium: 2, i.e. a stable octet).

This is accomplished by gaining _____ for non-metals, or by losing _____ by metals.

Sometimes, elements share electrons as for example, when atoms of the same element combine with one another.

The elements most willing to lose electrons are the _____ _____, or Group _____,
the non-metals most willing to gain electrons are the _____, or Group _____.

The Noble or Inert Gases are least willing to either _____ or _____ electrons, this is why they do not form compound very easily.

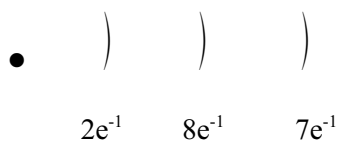
Answer the following questions using your table:

1. What particle determines the chemical properties of an element? _____

2. Name the external layer (shell) of electrons in an atom. _____ _____.

Electrons and Atomic Structure: Bohr Models

One method of symbolizing the electron configuration is by the following method:



The "**O**" represents the nucleus and each parenthesis represents a shell of electrons, the number under the parentheses are the total number of electrons found in that shell.

Metals have less than 4 electrons in the last shell, (the valence shell), whilst non-metals have more than 4 electrons in the last shell.

The most reactive metals, i.e. in Group _____ of the periodic table, have only 1 electron in the valence shell.

The most reactive non-metals have 7 electrons in the last shell, (valence shell).
The most reactive non-metal is _____.

By adding up the numbers under the parentheses in the Bohr diagram the atomic number of the element is obtained.

The maximum number of electrons in each shell is determined by the simple formula:

$2\ n^2$ (n = energy level number, positive integers only)

this means that the maximum number of electrons in the first shell, where 'n' = 1, is _____,

the second shell, n = 2 is: _____,

and the third shell, where n = 3 is _____, (however it is stable with 8).

Summary:

★ The simplified atomic model shows us electrons placed in concentric shells.

★ Each layer corresponds to an Energy Level.

★ The Levels are numbered starting from the one closest to the nucleus.

★ If "n" is the level number, the maximum number of electrons is given by: $2n^2$

★ The maximum number of electrons when n = 1 is ___, when n = 2 is ___, and when n = 3 is ___.

Assignment

Draw Bohr models for the first 20 elements in the Periodic Table provided, (Note: Leave ½ of each box in the periodic table to draw Lewis structures, see below).

Answer the following:

1. Does the number of valence electrons correspond to the group number in the first 20 elements?

2. Why is helium placed in Group VIII A ?

3. The periodic table is arranged in increasing number of _____.

4. As with atomic structure, the chemical properties are "periodic". What do we call a group of elements with similar chemical properties?

5. Does the present simplified Bohr model justify the structure of the periodic table of elements? Explain.

6. A good model permits the making of predictions. How does the atomic model permit the predicting of chemical properties of an element?

The Lewis Model

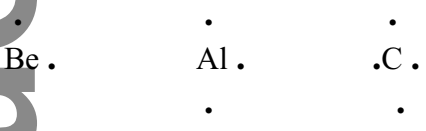
To study the chemical properties of the elements, only the valence shell is important.

The Lewis model diagrams only the valence electrons.

To draw Lewis models:

1. Write the symbol (this represents the core electrons).
2. Surround the symbol with dots representing the valence electrons.
3. One dot is placed per side, (treat the symbol as a square), until each side has one electron, then start doubling up.

Examples



Now Complete the Periodic Table provided, (same periodic table as the assignment above), to draw the Lewis structure for the first 20 elements, and their ions.

Answer the following:

1. Can you see a pattern?

2. What is the relationship between the number of valence electrons and the Group number of the periodic table?

3. What is the relationship between the elements and the number of electrons gained or lost, in order to attain the Nobel gas configuration.

4. What is the **charge on the ions formed** by elements in the following Groups, and state the **Noble gas that these ions would be isoelectronic** with:

   (a) Group I _____ _____

   (b) Group II _____ _____

   (c) Group VII _____ _____

5. Complete the worksheet: Ions and the Periodic Table.

6. Understanding Concepts, page 187, # 1 – 8