SNC1D
UNIT 2: CHEMISTRY
CHAPTER 5: UNDERSTANDING THE PROPERTIES OF ELEMENTS

5.3: THE PERIODIC TABLE

MENDELEEV'S ARRANGEMENT OF ELEMENTS **Page 195**

Russian chemist, Dimitri Mendeleev, is credited with the creation of the modern Periodic Table. In 1869, he arranged the 63 elements known at the time based on their **atomic size** and **properties**. He listed the elements in **rows** and **columns** in order of atomic weight and properties, beginning a new row or column when the properties changed. Mendeleev's brilliance was the **gaps** he left in the Periodic Table in which some undiscovered elements with **predicted properties** would fit.


Dimitri Mendeleev

THE MODERN PERIODIC TABLE **Page 197**

***Chemical Symbols*:**

- The symbols may be a **single letter**, **two letters**, or **three letters**
- The first letter is always capitalized with the other letters in lower case. For example, **Co** is the **element cobalt,** while **CO** is a **compound of carbon and oxygen** called **carbon monoxide**.
- The names and symbols may not reflect the English name, for example the symbol for lead is Fe, which comes from the Latin word ferrum.

The periodic table has a very recognizable shape. The elements are arranged in...

① **PERIODS** ⟺ **rows** ② **GROUPS (or families)** ⇕ **columns**

The elements in each GROUP have **similar physical and chemical properties**.

The **physical and chemical properties** of individual elements are determined by the **arrangement of the subatomic particles** inside an atom.

To understand why the elements are placed in their precise position in the table, it is necessary to consider the following:

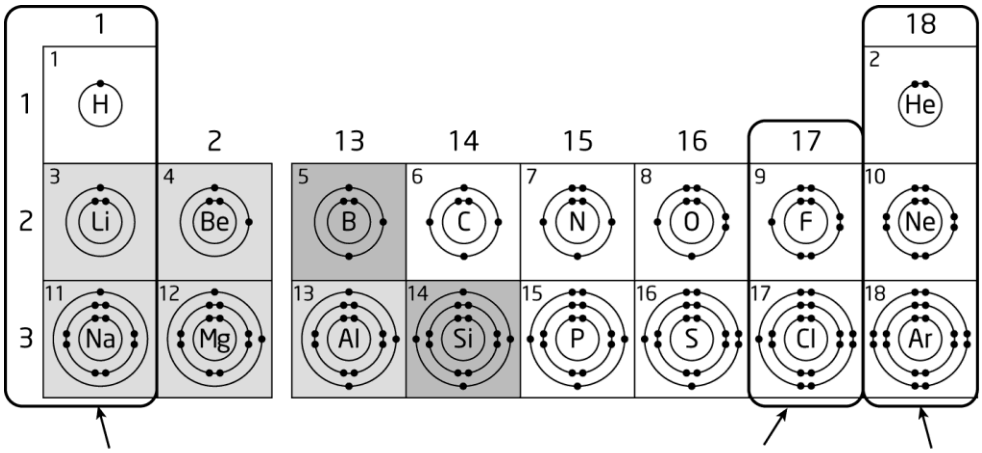
- the **arrangement of protons and neutrons** in each atom
- and more importantly, the **atom's electron configuration**.

To help you recognize **patterns** in the **electron configuration of elements** in the Periodic Table and make predictions about an element's behavior, complete the **Bohr-Rutherford Activity Chart** and **Bohr-Rutherford Periodic Table** below, then answer the questions that follow. Use Element #11 (done for you) as an example to complete the chart.

Bohr - Rutherford ACTIVITY CHART

Atomic Number	Element Symbol	Element Name	Standard Atomic Notation	# of Protons	# of Electrons	Mass Number	# of Neutrons	Electron Configuration
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11	Na	sodium	$^{23}_{11}Na$	11	11	23	12	2,8,1
12								
13								
14								
15								
16								
17								
18								
19								
20								

Bohr – Rutherford PERIODIC TABLE – Fill in the blanks below; then answer the questions that follow.



_____ _____ _____

1. What pattern do you see in the **number of electrons** moving from left to right in the periodic table?

2. a) Lithium, sodium and potassium all **behave similarly** in **chemical reactions**. How many electrons do these elements have in their **outer level**?

   b) Rubidium has the **same chemical behaviour** as lithium, sodium and potassium. Where is rubidium found on the periodic table in relation to lithium, sodium and potassium?

   c) How many electrons do you suppose that Rubidium has in its **outer level**?

3. a) Fluorine and chlorine both **behave similarly** in **chemical reactions**. How many electrons do these elements have in their **outer level**?

   b) Bromine has the **same chemical behaviour** as chlorine and fluorine. Where is bromine found on the periodic table in relation to chlorine and fluorine?

   c) How many electrons do you suppose that bromine has in its **outer level**?

4. a) Helium, neon, and argon **behave similarly** in **chemical reactions**. What do you notice about the **outer level** of electrons in these elements? Hint: How many electrons did Bohr say each element could have in its **outer shell**?

   b) Krypton has the **same chemical behaviour** as helium, neon, and argon. Where is Krypton found on the periodic table in relation to helium, neon, and argon?

   c) Using your answer in 4a) as a guide, explain what you would expect to see in the **outer electron orbit** of Krypton.

THE OUTER (or VALENCE) SHELL and the STABLE OCTET RULE

Any atom, in its **most stable state**, will have a **full outer shell**, called a **stable octet.**

An atom can obtain a full outer shell by one of the following methods:

a. **giving up** one or more electrons to other atoms
b. **gaining** one or more electrons by taking them from other atoms
c. **sharing** one or more electrons with other atoms.

1. How many valence electrons do all group 1 elements have?

2. What can you say about the outer shell for all group 18 elements?

3. How many electrons would a group 17 element need to obtain a full outer shell?

4. Would a group 2 element be more likely to gain or lose electrons? How many?

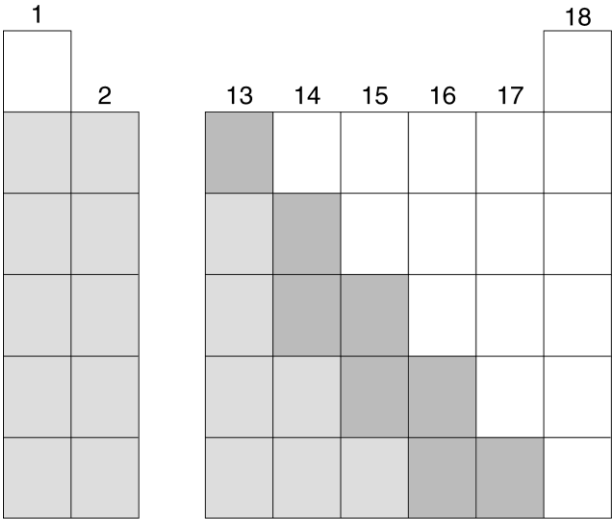
CLASSES OF ELEMENTS IN THE PERIODIC TABLE **Page 200**

METALS, NON-METALS, & METALLOIDS

On the Periodic Table, there is an **imaginary staircase** that helps to classify the different elements. If you draw this staircase starting between boron and carbon and going down to the right, then the elements on the right are **non-metals**, the elements on the left are **metals**, and the elements along the staircase are **metalloids**, with the exception of aluminum.

Use pencil crayons to write in the symbols for the elements that are metals **(blue)**, non-metals **(red)**, and metalloids **(green)** on the periodic table shown.

Add a legend to the diagram



METALS: **See table 5.2 on page 200**

- have a **shiny lustre**
- are **solid at room temperature** (except mercury, which is a liquid)
- are **good conductors** of heat and electricity
- are malleable

NON-METALS:

- are **not shiny**
- are either **gas or solid at room temperature** (except bromine, which is a liquid)
- are **poor conductors** of heat and electricity
- if solid, they are **brittle** (not malleable)

METALLOIDS:

- share properties of both metals and non-metals
- some are solids at room temperature and some are shiny
- some metalloids may conduct electricity but are poor conductors of heat.

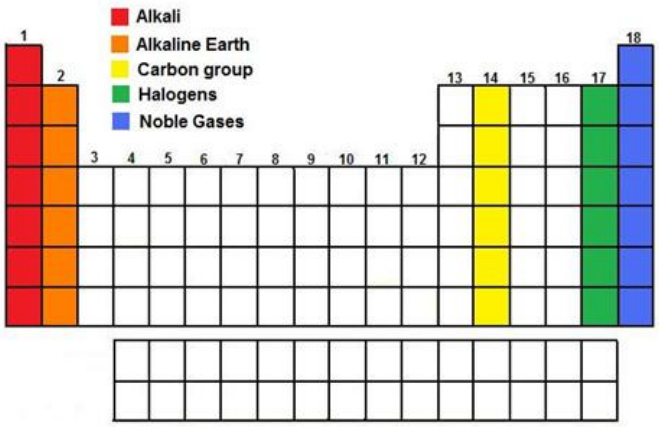
PERIODS and GROUPS in the PERIODIC TABLE **Pages 205 – 206**

PERIODS ⟺

Periods or rows in the table go left to right and elements in the same period all have the **same number of electron orbitals**. For example, all elements in row 1 only have 1 orbital and all elements in row 2 have 2 orbitals, and so on. Recall from the Bohr-Rutherford diagrams that as you move across the Periodic Table the outer orbital fills up with electrons until the far right of the Periodic Table where the outer orbital fills with 8 electrons.

GROUPS ⇕

Groups, also called **families**, describe the 18 columns in the Periodic Table The elements in groups all have **similar chemical properties** and they all contain the **same number of electrons in the outer orbital**. The names given to some of the groups include alkali metals, alkaline earth metals, halogens, and noble gases.



ALKALI METALS (Group 1): Some of these elements include lithium, sodium, and potassium. These elements are found on the far left of the Periodic table. They are shiny, silvery metals that form compounds that are soluble in water. Alkali elements are **very reactive** with other elements, therefore they are only **found as compounds in nature**. The atoms of these elements have only one electron in their outer orbit, which allows them to combine easily with other elements.

ALKALINE EARTH METALS (Group 2): Some of these elements include beryllium, magnesium, calcium, and strontium. They are shiny, silvery metals that form compounds that are insoluble in water. The atoms of alkaline earth metals have only two electrons in their outer orbit, which allow them to combine easily with other elements.

CARBON GROUP (Group 14): Some of these elements include carbon, silicon, tin, and lead. The properties as you move down the group change from non-metallic to metallic. Carbon and silicon are both brittle solids and may conduct electricity. For example, carbon in diamond form does not conduct electricity however in graphite form the carbon does conduct electricity. Lead, at the bottom of the group, is malleable and conducts electricity.

HALOGENS (Group 17): Some examples of halogens are fluorine, chlorine, bromine, and iodine. They are **the most reactive non-metals** and usually appear as compounds in nature. The outer orbit of a halogen atom has seven electrons.

NOBLE GASES (Group 18): The elements on the far right of the table are all **chemically inactive** and are also referred to as the **inert gases**. The outer shells of the noble gases are full with 8 electrons; an exception is helium with its first orbital filled with 2 electrons. Neon is used in advertising lights (e.g., Las Vegas) and helium is used in blimps and balloons.

Did you know?
Halogens are so reactive that they are used to kill bacteria; for example, chlorine is used in water supplies, and iodine is used on cuts. The first light bulbs used air however the oxygen in the air reacted with the filament of the light bulb making them burn out in minutes. Air is now replaced by argon, which is a noble gas, so it will not react with the filament even at very high temperatures.

5.3 REVIEW

BLM 5-7

1. CROSS OUT any statement that does NOT apply to Mendeleev's work on the atomic theory.
   a) He discovered radioactivity.
   b) He listed the elements in order of increasing atomic mass.
   c) He noticed that some chemical properties repeated again and again.
   d) He directed alpha particles at each element.
   e) He cut the list of elements into repeating pieces.
   f) He organized similar elements into columns.
   g) When he finished his periodic table, it still had some gaps.

2. Complete the table. One element is done for you.

	element	symbol	atomic number	atomic mass	standard atomic notation
a.	potassium – 39	K	19	39.1	
b.		P			
c.			7		
d.	iodine – 130				
e.		Sn			

3. Three metals are _____, _____, and _____.

4. Metals are alike in these four ways:

   a) _____ b) _____

   c) _____ d) _____

5. True or False?
   a.___ Most animals easily take up mercury when it is present on its own.
   b.___ Mercury is poisonous.
   c.___ Mercury is part of every natural environment.
   d.___ Methyl mercury in fish has been very harmful to Aboriginal people.
   e.___ Fluorescent light tubes do not contain mercury.

6. Which group of elements are not metals AND do not react with other elements?
   _____

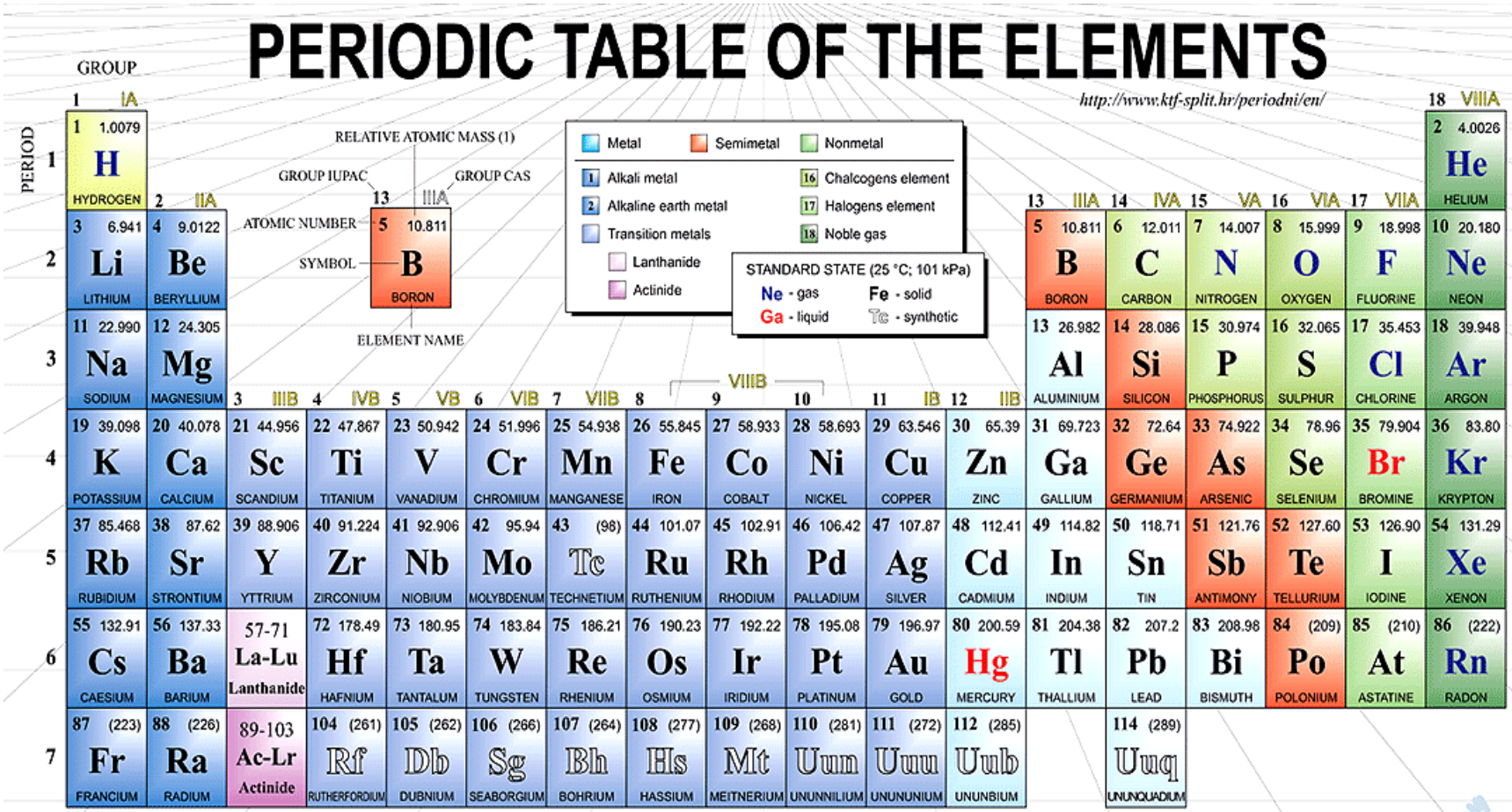
7. John wants to make a spoon out of sodium metal. This is a bad idea because
   _____

8. Complete the table.

	Location in Periodic Table	Name of Element	Symbol
a.	Group 2, Period 3		
b.	Group 14, Period 2		
c.	Group 18, Period 4		
d.	Group 6A, Period 3		
e.	Group 3A, Period 4		

PERIODIC TABLE OF THE ELEMENTS

http://www.ktf-split.hr/periodni/en/



(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)

Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.

However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

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