

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...



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.

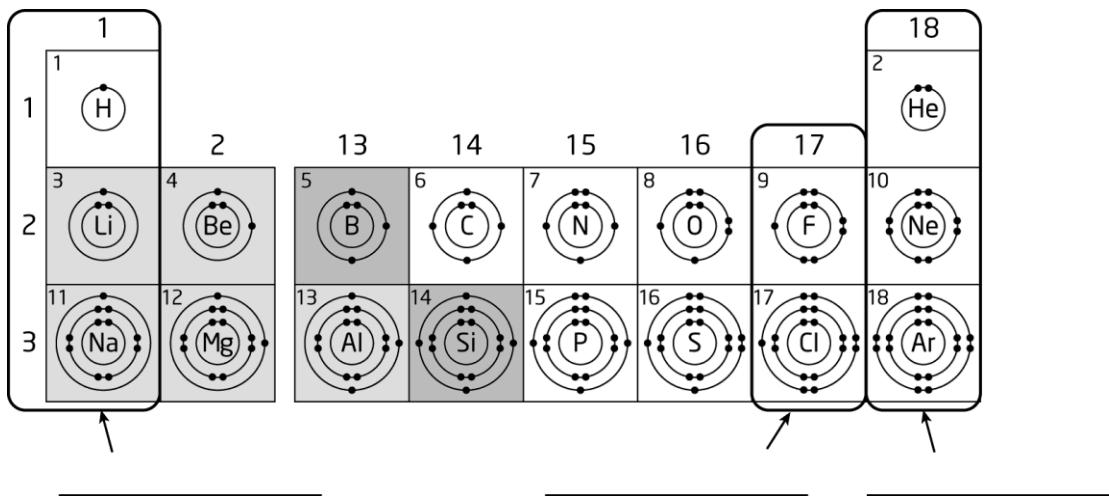
To understand why the elements are placed in their precise position in the table, it is necessary to consider the following:

- 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

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

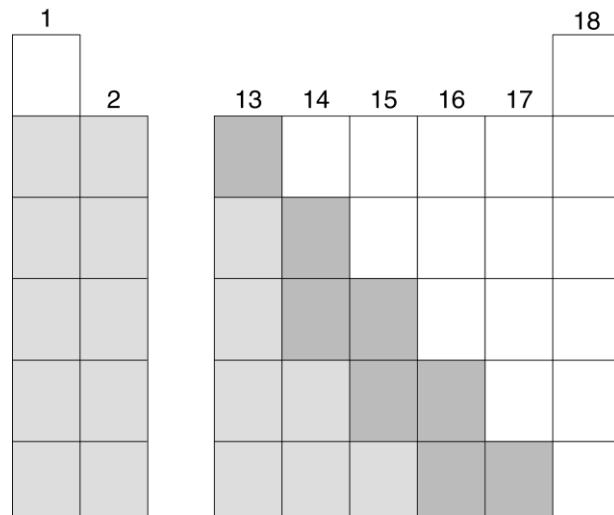
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METALS, NON-METALS, & METALLOIDS

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)

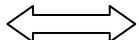
METALLOIDS:

- 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

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PERIODS

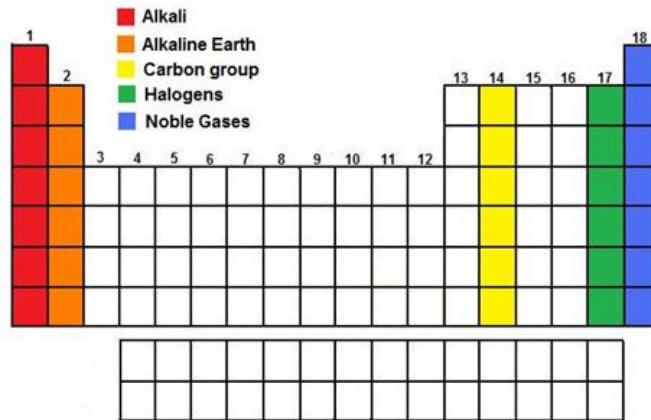


Periods or rows in the table go left to right and elements in the same period all have the **same number of electron orbitals**. For example, all elements in row 1 only have 1 orbital and all elements in row 2 have 2 orbitals, and so on. Recall from the Bohr-Rutherford diagrams that as you move across 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.

1. CROSS OUT any statement that does NOT apply to Mendeleev's work on the atomic theory.

- He discovered radioactivity.
- He listed the elements in order of increasing atomic mass.
- He noticed that some chemical properties repeated again and again.
- He directed alpha particles at each element.
- He cut the list of elements into repeating pieces.
- He organized similar elements into columns.
- 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:

- _____
- _____
- _____
- _____

5. True or False?

- ___ Most animals easily take up mercury when it is present on its own.
- ___ Mercury is poisonous.
- ___ Mercury is part of every natural environment.
- ___ Methyl mercury in fish has been very harmful to Aboriginal people.
- ___ 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.kif-split.hr/periodic/>

GROUP	PERIOD	RELATIVE ATOMIC MASS (1)	STANDARD STATE (25°C, 101 kPa)
1	1	1.0079	H - gas
2	1	2.0140	He - liquid
3	1	6.941	Li - solid
4	2	9.0122	Be - solid
5	2	12.011	B - synthetic
6	3	10.811	B - solid
7	3	11.999	C - solid
8	3	14.007	N - gas
9	3	15.999	O - gas
10	3	18.998	F - gas
11	3	20.180	Ne - gas
12	3	22.990	Ar - gas
13	3	26.982	Al - solid
14	4	28.086	Si - solid
15	4	30.974	P - solid
16	4	32.065	S - solid
17	4	35.453	Cl - solid
18	4	39.948	Br - solid
19	5	40.078	K - solid
20	5	44.956	Ca - solid
21	5	47.867	Sc - solid
22	5	50.942	Ti - solid
23	5	51.996	Cr - solid
24	5	54.938	Mn - solid
25	5	55.845	Fe - solid
26	5	56.933	Co - solid
27	5	58.693	Ni - solid
28	5	63.546	Cu - solid
29	5	65.39	Zn - solid
30	5	69.723	Ga - solid
31	5	72.64	Ge - solid
32	5	74.922	As - solid
33	5	78.96	Se - solid
34	5	79.904	Br - solid
35	5	83.80	Kr - solid
36	6	87.62	Rb - solid
37	6	98.906	Sr - solid
38	6	101.224	Y - solid
39	6	124.468	Zr - solid
40	6	124.906	Nb - solid
41	6	136.924	Mo - solid
42	6	139.94	Tc - solid
43	6	140.107	Ru - solid
44	6	141.07	Rh - solid
45	6	142.91	Pd - solid
46	6	146.42	Ag - solid
47	6	147.87	Cd - solid
48	6	148.41	In - solid
49	6	149.82	Sn - solid
50	6	151.71	Sh - solid
51	6	151.76	Te - solid
52	6	152.60	I - solid
53	6	153.90	Xe - solid
54	6	154.129	
55	7	137.33	Rb - solid
56	7	137.33	Strontium - solid
57	7	178.49	Yttrium - solid
58	7	180.95	La-Lu - solid
59	7	183.84	Scandium - solid
60	7	186.21	Actinide - solid
61	7	190.23	Actinide - solid
62	7	192.22	Actinide - solid
63	7	195.08	Actinide - solid
64	7	196.97	Actinide - solid
65	7	200.59	Actinide - solid
66	7	204.38	Actinide - solid
67	7	207.2	Actinide - solid
68	7	208.96	Actinide - solid
69	7	210.24	Actinide - solid
70	7	213.04	Actinide - solid
71	7	214.97	Actinide - solid
72	7	222.02	Actinide - solid
73	7	223.03	Actinide - solid
74	7	226.03	Actinide - solid
75	7	227.04	Actinide - solid
76	7	228.03	Actinide - solid
77	7	231.04	Actinide - solid
78	7	237.04	Actinide - solid
79	7	238.03	Actinide - solid
80	7	239.04	Actinide - solid
81	7	240.04	Actinide - solid
82	7	241.04	Actinide - solid
83	7	242.04	Actinide - solid
84	7	243.04	Actinide - solid
85	7	244.04	Actinide - solid
86	7	245.04	Actinide - solid
87	7	246.04	Actinide - solid
88	7	247.04	Actinide - solid
89	7	248.04	Actinide - solid
90	7	249.04	Actinide - solid
91	7	250.04	Actinide - solid
92	7	251.04	Actinide - solid
93	7	252.04	Actinide - solid
94	7	253.04	Actinide - solid
95	7	254.04	Actinide - solid
96	7	255.04	Actinide - solid
97	7	256.04	Actinide - solid
98	7	257.04	Actinide - solid
99	7	258.04	Actinide - solid
100	7	259.04	Actinide - solid
101	7	260.04	Actinide - solid
102	7	261.04	Actinide - solid
103	7	262.04	Actinide - solid
104	7	263.04	Actinide - solid
105	7	264.04	Actinide - solid
106	7	265.04	Actinide - solid
107	7	266.04	Actinide - solid
108	7	267.04	Actinide - solid
109	7	268.04	Actinide - solid
110	7	269.04	Actinide - solid
111	7	270.04	Actinide - solid
112	7	271.04	Actinide - solid
113	7	272.04	Actinide - solid
114	7	273.04	Actinide - solid
115	7	274.04	Actinide - solid
116	7	275.04	Actinide - solid
117	7	276.04	Actinide - solid
118	7	277.04	Actinide - solid
119	7	278.04	Actinide - solid
120	7	279.04	Actinide - solid
121	7	280.04	Actinide - solid
122	7	281.04	Actinide - solid
123	7	282.04	Actinide - solid
124	7	283.04	Actinide - solid
125	7	284.04	Actinide - solid
126	7	285.04	Actinide - solid
127	7	286.04	Actinide - solid
128	7	287.04	Actinide - solid
129	7	288.04	Actinide - solid
130	7	289.04	Actinide - solid
131	7	290.04	Actinide - solid
132	7	291.04	Actinide - solid
133	7	292.04	Actinide - solid
134	7	293.04	Actinide - solid
135	7	294.04	Actinide - solid
136	7	295.04	Actinide - solid
137	7	296.04	Actinide - solid
138	7	297.04	Actinide - solid
139	7	298.04	Actinide - solid
140	7	299.04	Actinide - solid
141	7	300.04	Actinide - solid
142	7	301.04	Actinide - solid
143	7	302.04	Actinide - solid
144	7	303.04	Actinide - solid
145	7	304.04	Actinide - solid
146	7	305.04	Actinide - solid
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161	7	320.04	Actinide - solid
162	7	321.04	Actinide - solid
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164	7	323.04	Actinide - solid
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