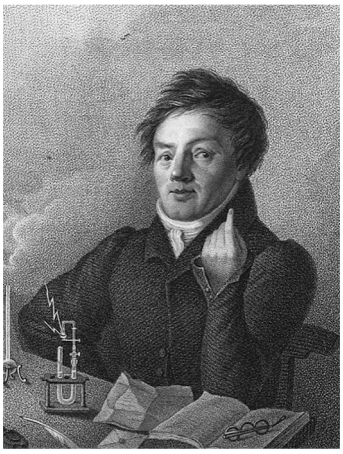
# Classifying Elements

## Döbereiner's Elemental Triads

Elements repeat properties in groups of three based on mass. The mass of the middle element is the average of the mass of the first and third element.

| Set I | | Set II | | Set-III | |
|---|---|---|---|---|---|
| Element | Atomic mass | Element | Atomic mass | Element | Atomic mass |
| Calcium | 40 | Lithium | 7 | Chlorine | 35.5 |
| Strontium | 87.5 | Sodium | 23 | Bromine | 80 |
| Barium | 137 | Potassium | 39 | Iodine | 127 |
| Average of the atomic masses of calcium and barium $= \frac{40+137}{2} = 88.5$ | | Average of the atomic masses of lithium and potassium $= \frac{7+39}{2} = 23$ | | Average of the atomic masses of chlorine and iodine $= \frac{35.5+127}{2} = 81.2$ | |
| Atomic mass of strontium = 87.5 | | Atomic mass of sodium = 23 | | Atomic mass of bromine = 80 | |



**Johann Döbereiner**

*German Chemist*

*1780 – 1840AD*

2

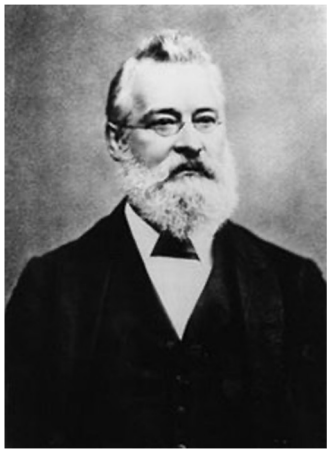
# Classifying Elements

## *Newland's Law of Octaves*

**Table 4.2** Newland's table of octaves (oct- eight)

| NO. | NO. | NO. | NO. | NO. | NO. | NO. | NO. |
|---|---|---|---|---|---|---|---|
| H1 | F8 | Cl 15 | Co&Ni 22 | Br 29 | Pd 36 | I 42 | Pt & Ir 50 |
| Li 2 | Na 9 | K 16 | Cu 23 | Rb 30 | Ag 37 | Cs 44 | Os 51 |
| G 3 | Mg 10 | Ca 17 | Zn 24 | Sr 31 | Cd 38 | Ba & V45 | Hg 52 |
| BO 4 | Al 11 | Cr 19 | Y 25 | Ce & La33 | U40 | Ta 46 | Ti 53 |
| C 5 | Si 12 | Ti 18 | In 26 | Zr 32 | Sn 39 | W 47 | Pb 54 |
| N 6 | P 13 | Mn 20 | As 27 | Di&Mo 34 | Sb 41 | Nb 48 | Bi 55 |
| O7 | S 14 | Fe 21 | Se 28 | Ro&Ru 35 | To 43 | Au 49 | Th 56 |

Elements repeat properties when arranged in rows (*periods*) of 8 elements (*the octave*)



**John Newlands**

*British Chemist*

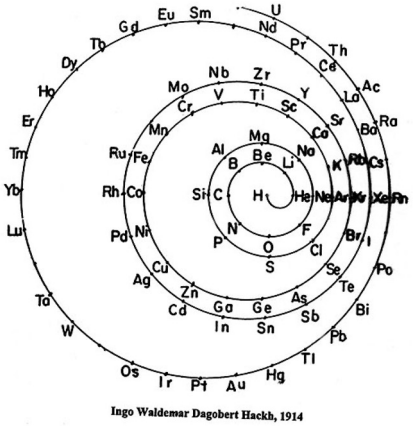
*1837 – 1898AD*

3

# Classifying Elements

## Hinrick's Spiral Periodic Table

Elements repeat properties when arranged into a double spiral. The spiral doubles over when elements of similar properties come near each other




**Gustavus Hinrichs**
*German Chemist*
*1836 – 1924AD*

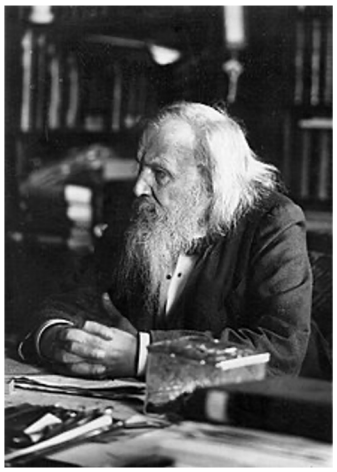
4

# Classifying Elements

## Mendeleev's Periodic Table

| 0 | H 1.01 | II | III | IV | V | VI | VII | |
|---|---|---|---|---|---|---|---|---|
| He 4.00 | Li 6.94 | Be 9.01 | B 10.8 | ● C 12.0 | N 14.0 | O 16.0 | F 19.0 | |
| Ne 20.2 | Na 23.0 | Mg 24.3 | Al 27.0 | Si 28.1 | P 31.0 | ● S 32.1 | Cl 35.5 | VIII |
| Ar 40.0 | K 39.1 | Ca 40.1 | Sc 45.0 | Ti 47.9 | V 50.9 | Cr 52.0 | Mn 54.9 | ● Fe 55.9 Co 58.9 Ni 58.7 |
| | ●Cu 63.5 | Zn 65.4 | Ga 69.7 | Ge 72.6 | As 74.9 | Se 79.0 | Br 79.9 | |
| Kr 83.8 | Rb 85.5 | Sr 87.6 | Y 88.9 | Zr 91.2 | Nb 92.9 | Mo 95.9 | Tc (99) | Ru 101 Rh 103 Pd 106 |
| | ●Ag 108 | Cd 112 | In 115 | ●Sn 119 | Sb 122 | Te 128 | I 127 | |
| Xe 131 | Ce 133 | Ba 137 | ○ La 139 | Hf 179 | Ta 181 | W 184 | Re 180 | Os 194 Ir 192 Pt 195 |
| | ●Au 197 | ●Hg 201 | Tl 204 | ●Pb 207 | Bi 209 | Po (210) | At (210) | |
| Rn (222) | Fr (223) | Ra (226) | ●Ac (227) | ●Th 232 | ●Pa (231) | ● U 238 | | ○ Lanthanide series |
| | | | | | | | | ● Actinide series |
| Dobereiner's triads | | | | Known to Mendeleev | | | | ● Known to Ancients |

Elements repeat properties when arranged by atomic mass. (*rows and periods*)



**Dmitri Mendeleev**
*Russian Chemist*
*1834 – 1907AD*

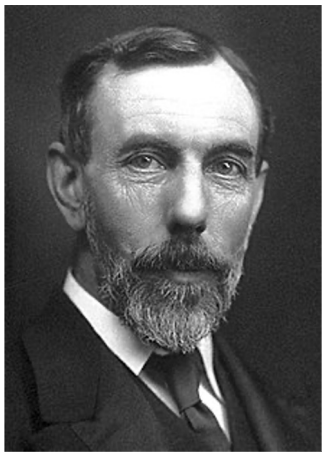
5

# Classifying Elements

## Discovery of the Noble Gases

Ramsay along with other scientists of the time purified a new inert (can't react) gas, the noble gases, the final group of the periodic table

| Noble Gas: | First discovered | Who Discovered |
|---|---|---|
| Helium | August 18th, 1869 [11] | Pierre-Jules-César Janssen |
| Neon | 1898 | Sir William Ramsay and Morris W. Travers |
| Argon | 1894 | Sir William Ramsay and Lord Rayleigh |
| Krypton | May 30, 1898 [12] | Sir William Ramsay and Morris W. Travers |
| Xenon | July 12, 1898 [13] | Sir William Ramsay |
| Radon | 1900 | Friedrich Ernst Dorn |
| Unnoctium | 2002 | Scientists in the Joint Institute for Nuclear Research and Lawrence Livermore National Laboratory [13] |



**William Ramsay**

*Scottish Chemist*

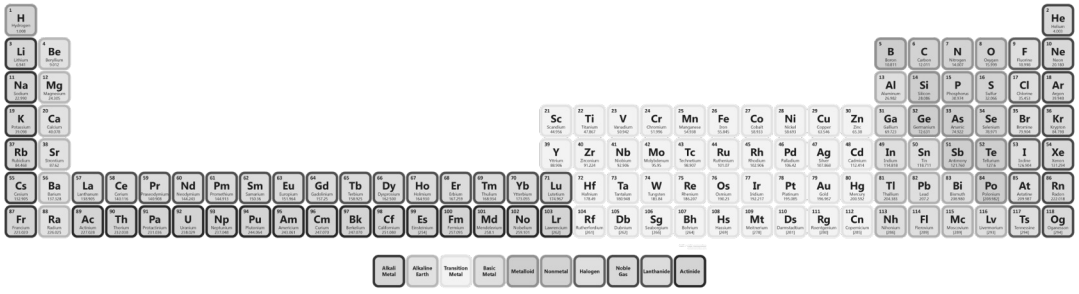
*1852 – 1916AD*

6

# Classifying Elements

## Modern Periodic Table

With the discovery of the subatomic particles ($e^-$, $p^+$, and $n^o$), and the nucleus, the modern periodic table was arranged by atomic number.



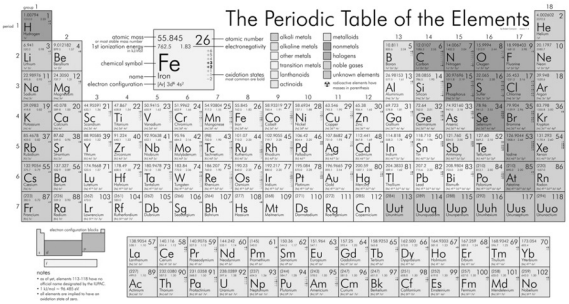
7

# Periodic Table

The **periodic table** is a chart (*table*) of elements arranged based on their **properties** (*the attributes that make something unique in science*)

## Element Properties

Elements have **properties** that make them *different from all other elements* based on structural similarities in protons ($p^+$), electrons ($e^-$) and orbital structure



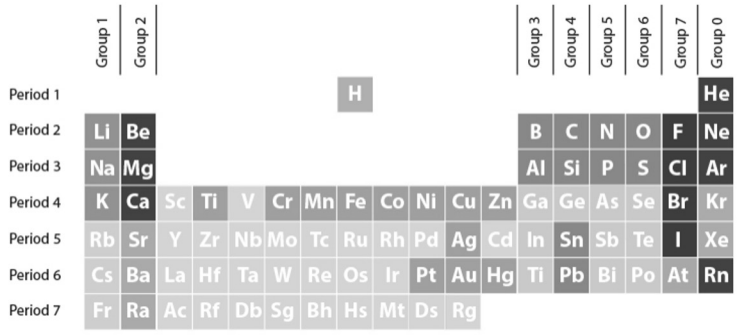

The **periodic table** shown above illustrates the common *groupings* of elements based on the element characteristics

8

# Modern Periodic Table

## Groups and Periods

Elements are arranged into groups (*up and down*), and periods (*left to right*) based on atomic number.




The periodic table is arranged into 8 groups and 7 periods.

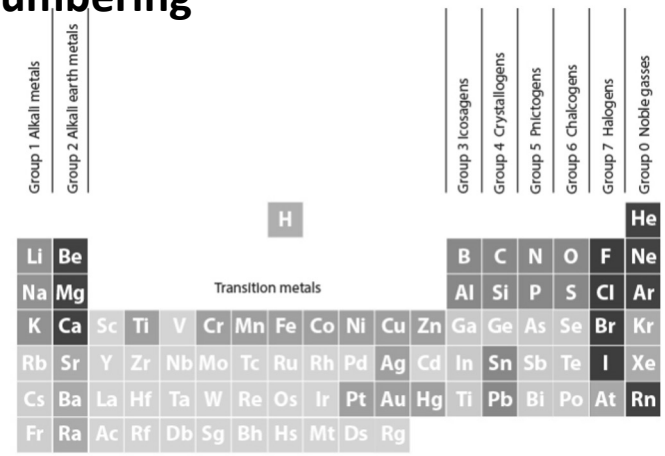
9

# Modern Periodic Table

## Groups Naming and Numbering

Groups are numbered in two ways (*modern + trad*)

1 (1A) – Alkali Metals
2 (2A) – Alkali Earth Metals
13 (3A) – Earth Metals
15 (5A) – Pnictogens
16 (6A) – Chalcogens
17 (7A) – Halogens
18 (8A) – Noble Gases

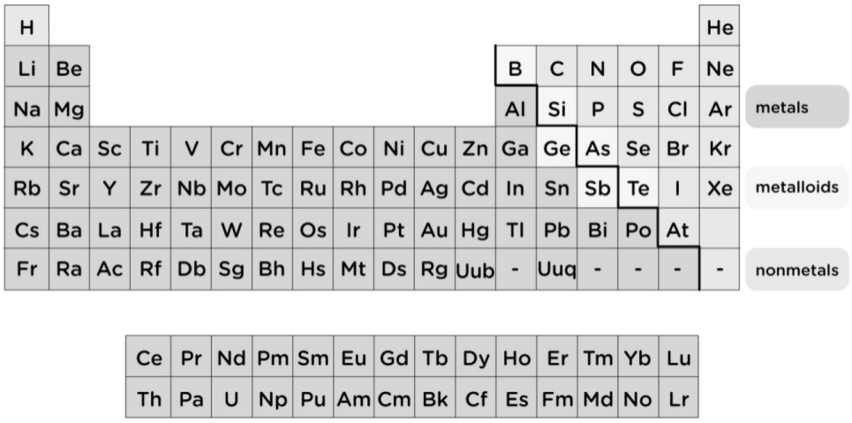



10

# Modern Periodic Table

## Metals, Non-Metals, and Metalloids

Main groups on the table are shown here (*metals, metalloids, & non-metals*) based on how elements react together

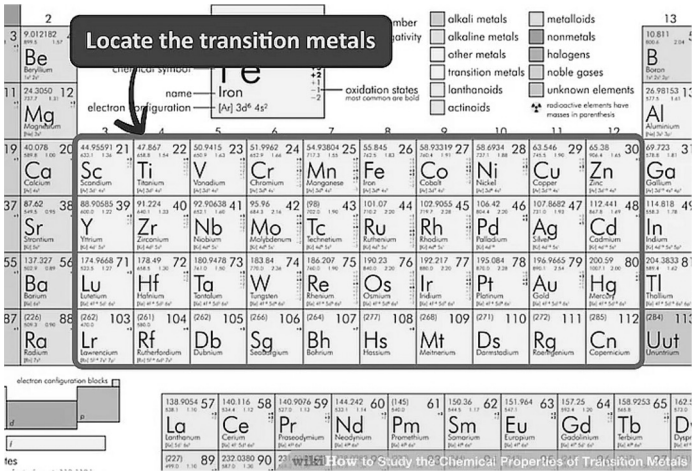



11

# Modern Periodic Table

## Transitional Metals

3 – 12, 1B – 10B
Metals in the center of the table that react and behave different from other metals in groups 1A (1) and 2A (2). Metals in 3A (13), and 4A (14) have properties like transition metals.




12