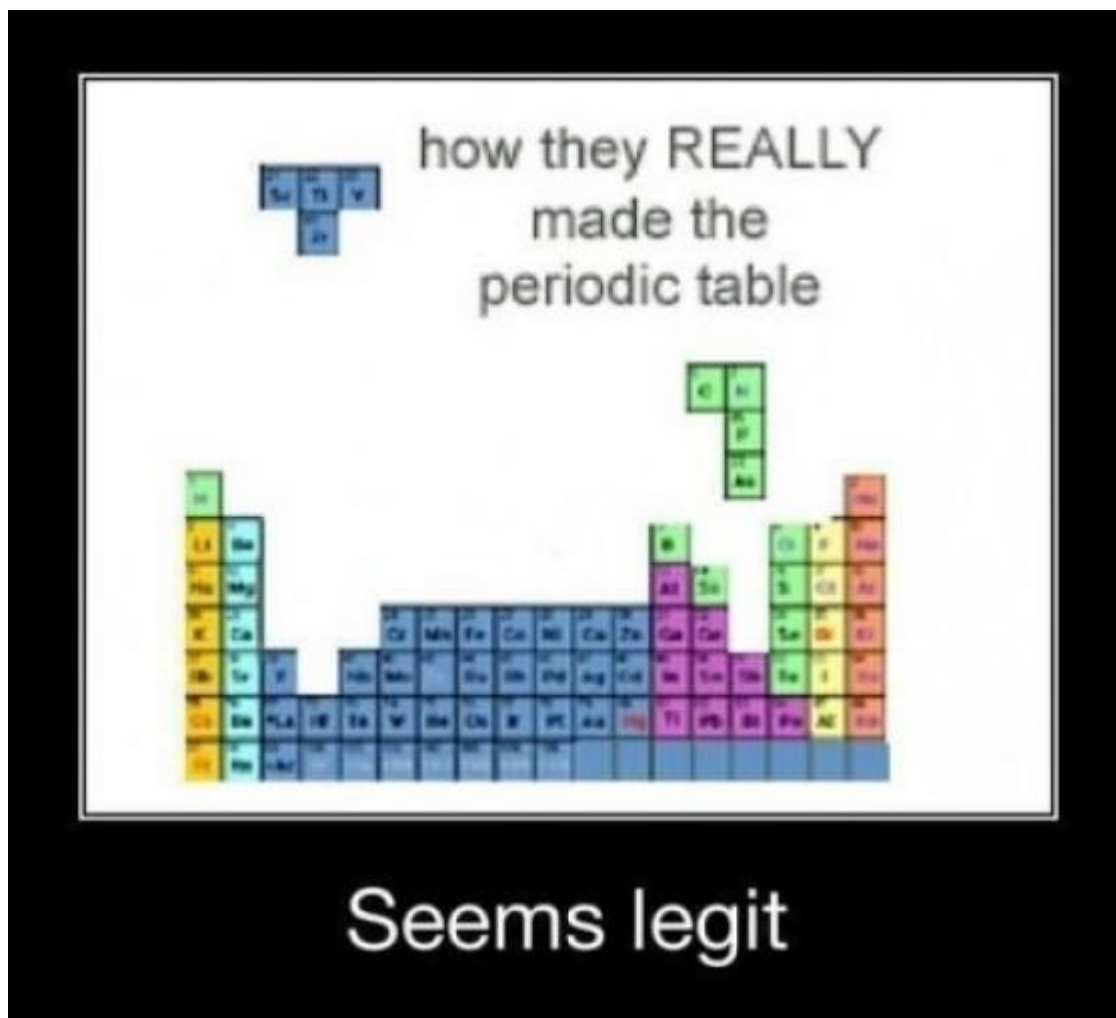


# The Periodic Table



S1-2-06 Investigate the development of the periodic table as a method of organizing elements. Include: periods, families (groups)

# The Periodic Table...

As elements were being discovered, scientists were trying to **CATEGORIZE** and **ORGANIZE** them in a way that makes sense.

Today we have the modern periodic table that we have all seen before:

The image shows a standard periodic table of elements, color-coded by groups. The title is "Periodic Table of the Elements". The table is organized into rows and columns, with atomic numbers and chemical symbols for each element. The elements are arranged in order of increasing atomic number from top-left to bottom-right. The table includes the following elements:

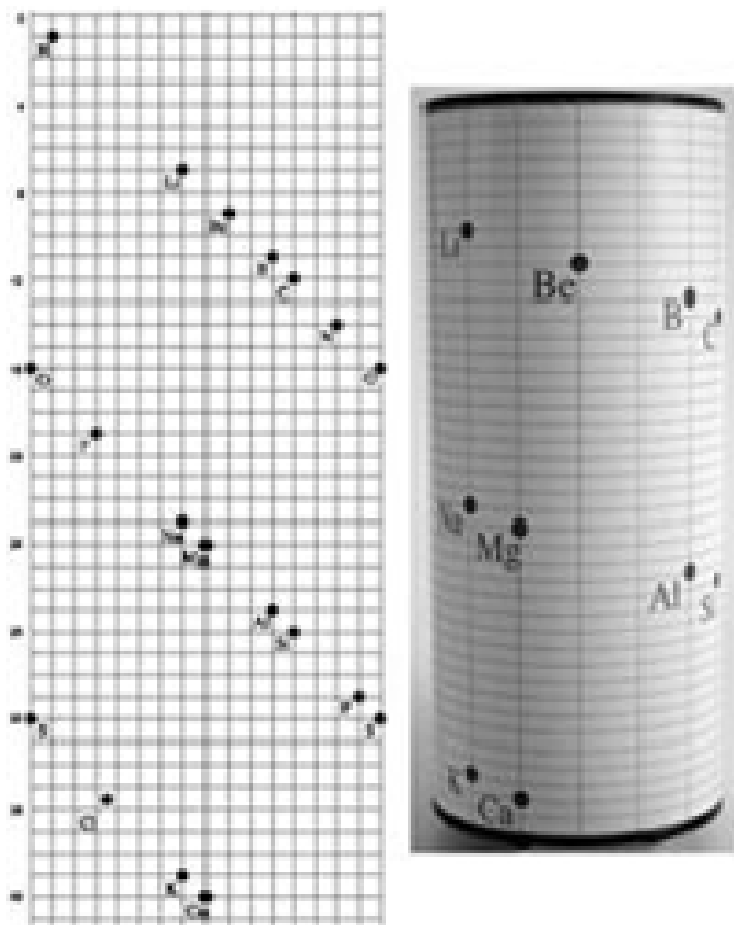
| 1                    | 2                    | 3                    | 4                  | 5                  | 6                  | 7                    | 8                    | 9                    | 10                   | 11                   | 12                   | 13                   | 14                    | 15                    | 16                    | 17                    | 18                 |
|----------------------|----------------------|----------------------|--------------------|--------------------|--------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------------|
| 1<br>H<br>1.01       |                      |                      |                    |                    |                    |                      |                      |                      |                      |                      |                      |                      |                       |                       |                       |                       | 2<br>He<br>4.00    |
| 3<br>Li<br>6.94      | 4<br>Be<br>9.01      |                      |                    |                    |                    |                      |                      |                      |                      |                      |                      | 5<br>B<br>10.81      | 6<br>C<br>12.01       | 7<br>N<br>14.01       | 8<br>O<br>16.00       | 9<br>F<br>18.99       | 10<br>Ne<br>20.18  |
| 11<br>Na<br>22.99    | 12<br>Mg<br>24.31    |                      |                    |                    |                    |                      |                      |                      |                      |                      |                      | 13<br>Al<br>26.98    | 14<br>Si<br>28.09     | 15<br>P<br>30.97      | 16<br>S<br>32.07      | 17<br>Cl<br>35.45     | 18<br>Ar<br>39.95  |
| 19<br>K<br>39.10     | 20<br>Ca<br>40.08    | 21<br>Sc<br>44.96    | 22<br>Ti<br>47.88  | 23<br>V<br>50.94   | 24<br>Cr<br>52.00  | 25<br>Mn<br>54.94    | 26<br>Fe<br>55.85    | 27<br>Co<br>58.93    | 28<br>Ni<br>58.69    | 29<br>Cu<br>63.55    | 30<br>Zn<br>65.39    | 31<br>Ga<br>69.72    | 32<br>Ge<br>72.64     | 33<br>As<br>74.92     | 34<br>Se<br>78.96     | 35<br>Br<br>79.90     | 36<br>Kr<br>83.80  |
| 37<br>Rb<br>85.47    | 38<br>Sr<br>87.62    | 39<br>Y<br>88.91     | 40<br>Zr<br>91.22  | 41<br>Nb<br>92.91  | 42<br>Mo<br>95.94  | 43<br>Tc<br>(97.91)  | 44<br>Ru<br>101.07   | 45<br>Rh<br>101.07   | 46<br>Pd<br>106.42   | 47<br>Ag<br>107.87   | 48<br>Cd<br>112.41   | 49<br>In<br>114.82   | 50<br>Sn<br>118.71    | 51<br>Sb<br>121.76    | 52<br>Te<br>127.60    | 53<br>I<br>126.91     | 54<br>Xe<br>131.29 |
| 55<br>Cs<br>132.91   | 56<br>Ba<br>137.33   | 57<br>La<br>138.91   | 58<br>Ce<br>140.12 | 59<br>Pr<br>140.91 | 60<br>Nd<br>144.24 | 61<br>Pm<br>(144.91) | 62<br>Sm<br>150.36   | 63<br>Eu<br>151.96   | 64<br>Gd<br>157.25   | 65<br>Tb<br>158.93   | 66<br>Dy<br>162.50   | 67<br>Ho<br>164.93   | 68<br>Er<br>167.26    | 69<br>Tm<br>168.93    | 70<br>Yb<br>173.04    | 71<br>Lu<br>174.97    |                    |
| 87<br>Fr<br>(223.02) | 88<br>Ra<br>(226.02) | 89<br>Ac<br>(227.03) | 90<br>Th<br>232.04 | 91<br>Pa<br>231.04 | 92<br>U<br>238.03  | 93<br>Np<br>(237.04) | 94<br>Pu<br>(244.06) | 95<br>Am<br>(243.06) | 96<br>Cm<br>(247.07) | 97<br>Bk<br>(247.07) | 98<br>Cf<br>(251.08) | 99<br>Es<br>(252.08) | 100<br>Fm<br>(257.10) | 101<br>Md<br>(258.10) | 102<br>No<br>(259.10) | 103<br>Lr<br>(260.10) |                    |

It took many attempts to get to the table you see above, here are some examples:

# Early Attempts at the Periodic Table...

## 1862 - A.E. Beguyer de Chancourtois

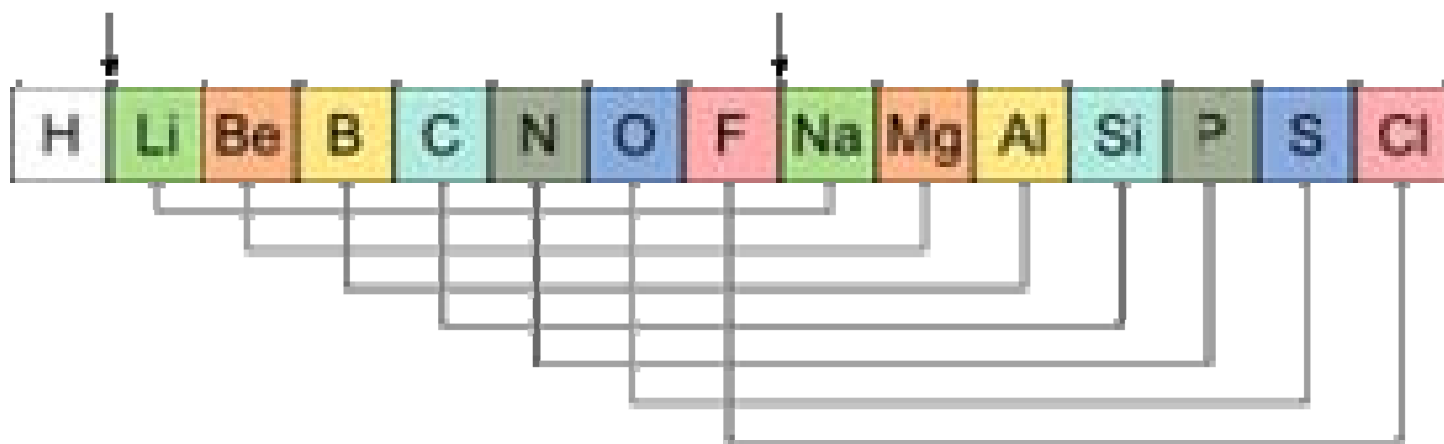
Listed the elements positioned on a cylinder in terms of **ATOMIC WEIGHT** and noticed that elements with similar **PROPERTIES** lined up.



# Early Attempts at the Periodic Table...

1864 – John Newlands

Law of OCTAVES which stated that elements REPEATED their chemical properties every EIGHTH element



# Early Attempts at the Periodic Table...

## 1868 – Lothar Meyer

First to recognize a REPEATING pattern of PROPERTIES when elements were organized by MASS

Periodic table according to Lothar Meyer, 1870

| I.      | II.      | III.     | IV.        | V.       | VI.       | VII.      | VIII.      | IX.      |
|---------|----------|----------|------------|----------|-----------|-----------|------------|----------|
|         | B=11,0   | Al=27,3  |            | --       |           | ?In=113,4 | Tl=202,7   |          |
|         | C=11,97  | Si=28    | --         | --       |           | Sn=117,8  | --         | Pb=206,4 |
|         | N=14,01  | P=30,9   | Ti=48      |          | Zr=89,7   | Sb=122,1  | --         | Bi=207,5 |
|         | O=15,96  | 31,98    | V=51,2     |          | Nb=93,7   | Te=128?   | Ta=182,2   | --       |
|         |          |          | Cr=52,4    |          | Mo=95,6   | W=183,5   |            |          |
| --      | F=19,1   | Cl=35,38 |            | Br=79,75 |           | J=126,5   |            | --       |
|         |          |          | Mn=54,8    |          | Ru=103,5  |           | Os=198,6 ? |          |
|         |          |          | Fe=55,9    |          | Rh=104,1  |           | Ir=196,7   |          |
|         |          |          | Co=Ni=58,6 |          | Pd=106,2  |           | Pt=196,7   |          |
| Li=7,01 | Na=22,99 | K=39,04  |            | Rb=85,2  |           | Cs=132,7  |            | --       |
|         |          |          | Cu=63,3    |          | Ag=107,66 |           | Au=196,2   |          |
| ?Be=9,3 | Mg=23,9  | Ca=39,9  |            | Sr=87,0  |           | Ba=136,8  |            | --       |
|         |          |          | Zn=64,9    |          | Cd=111,6  |           | Hg=199,8   |          |



# Early Attempts at the Periodic Table...

## Henry Mosely (1901):

Found that **PHYSICAL** and **CHEMICAL PROPERTIES** are related to their **ATOMIC NUMBER** (# protons) *not* **ATOMIC MASS**.

Created the **MODERN** periodic table in which each element has **ONE MORE PROTON** and **ELECTRON** than the one before it.

When elements are arranged this way, the **REPEATING PATTERN** of similar properties is called the **PERIODIC LAW**.



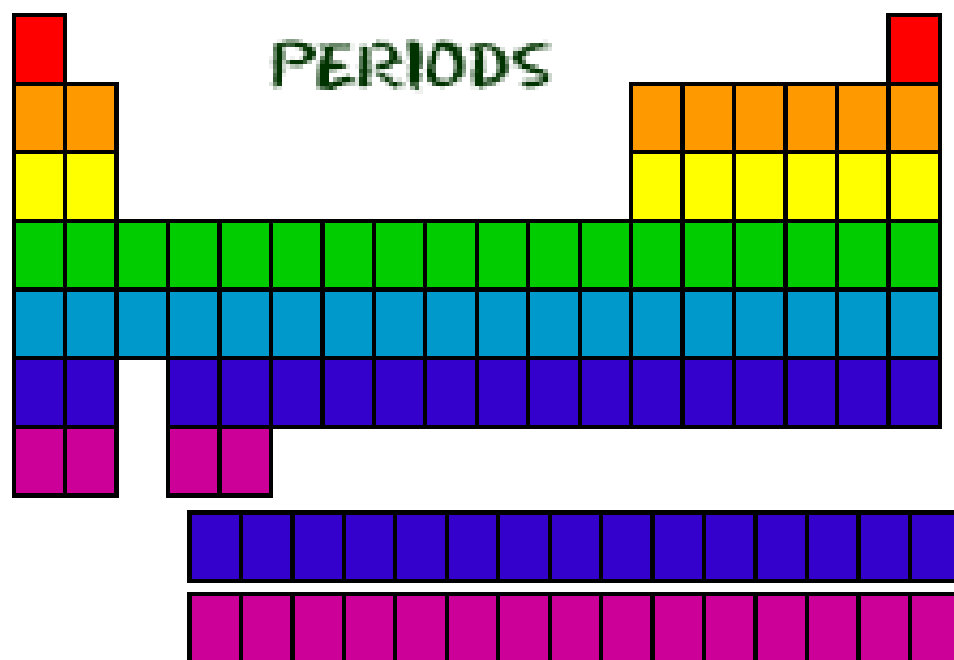
| Group 0 | I     |       | II     |       | III   |       | IV    |                     | V    |   | VI   |   | VII   |   | VIII |
|---------|-------|-------|--------|-------|-------|-------|-------|---------------------|------|---|------|---|-------|---|------|
|         | a     | b     | a      | b     | a     | b     | a     | b                   | a    | b | a    | b | a     | b |      |
| H 1     |       |       |        |       |       |       |       |                     |      |   |      |   |       |   |      |
| He 2    | Li 3  |       | Be 4   |       | B 5   |       | C 6   |                     | N 7  |   | O 8  |   | F 9   |   |      |
| Ne 10   | Na 11 |       | Mg 12  |       | Al 13 |       | Si 14 |                     | P 15 |   | S 16 |   | Cl 17 |   |      |
| Ar 18   | K 19  | Ca 20 | Sc 21  | Ti 22 | V 23  | Cr 24 | Mn 25 | Fe 26, Co 27, Ni 28 |      |   |      |   |       |   |      |
|         | Cu 29 | Zn 30 | Ga 31  | Ge 32 | As 33 | Se 34 | Br 35 |                     |      |   |      |   |       |   |      |
| Kr 36   | Rb 37 | Sr 38 | Y 39   | Zr 40 | Nb 41 | Mo 42 | -     | Ru 44, Rh 45, Pd 46 |      |   |      |   |       |   |      |
|         | Ag 47 | Cd 48 | In 49  | Sn 50 | Sb 51 | Te 52 | I 53  |                     |      |   |      |   |       |   |      |
| Xe 54   | Cs 55 | Ba 56 | 57-71* | Hf 72 | Ta 73 | W 74  | Re 75 | Os 76, Ir 77, Pt 78 |      |   |      |   |       |   |      |
|         | Au 79 | Hg 80 | Tl 81  | Pb 82 | Bi 83 | Po 84 | -     |                     |      |   |      |   |       |   |      |
| Rn 86   | -     | Ra 88 | Ac 89  | Th 90 | Pa 91 | U 92  |       |                     |      |   |      |   |       |   |      |

Today we know that it is the **ELECTRON** that determines the **PROPERTIES** of an **ELEMENT**, and the **NUMBER** of **ELECTRONS** is related to the **ATOMIC NUMBER**, not **ATOMIC MASS**.

# How the table is organized...

## Periods:

- **HORIZONTAL ROWS** on the periodic table, with the numbering system **1-7** from **TOP** to **BOTTOM** of the periodic table.
- Each **PERIOD** represents an **ENERGY LEVEL (ELECTRON SHELL)**
- Think of your time table for your classes.

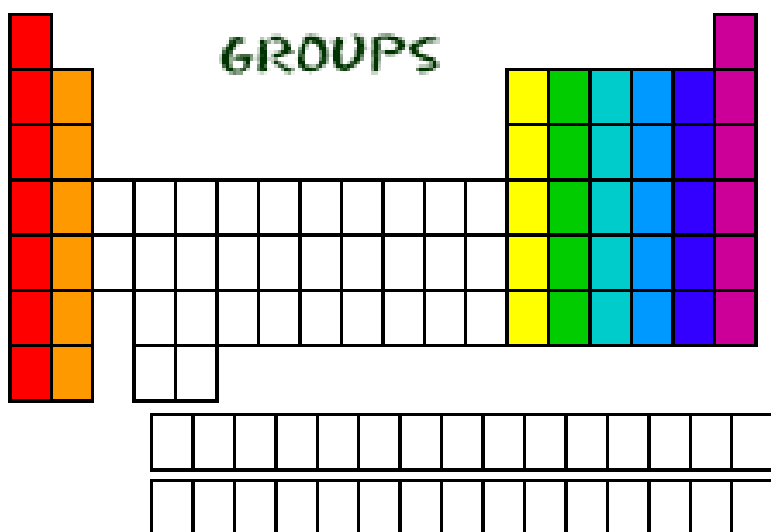




# How the table is organized...

## Groups/Families:

- VERTICAL COLUMNS on the periodic table.
- Labelled 1-18
- elements with SIMILAR CHEMICAL PROPERTIES.
- Elements in a GROUP all have the SAME NUMBER of VALENCE ELECTRONS.
- The number of VALENCE ELECTRONS is the same as the group number – kind of.



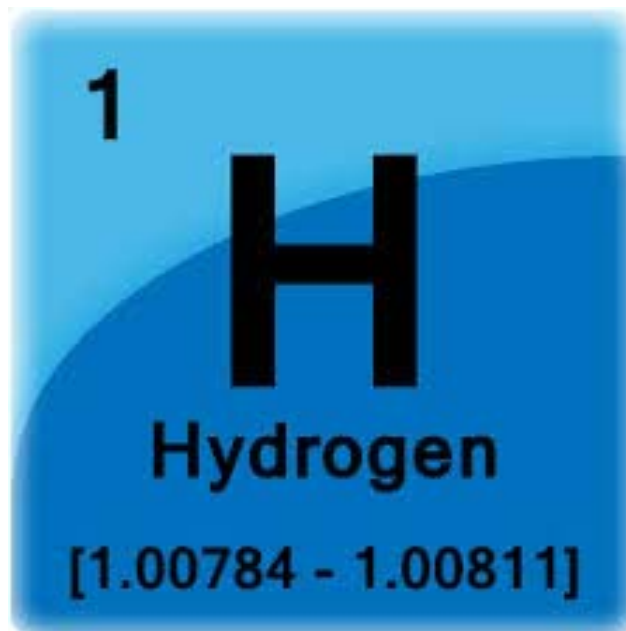
# Families of the Periodic Table...

The elements in a column (Family) on the periodic table **BEHAVE** in a **SIMILAR** way, just like with human families.

There are 6 families that we must look at:

## **1. Hydrogen (in it's own family):**

- Has **1 VALENCE ELECTRON**.
- **REACTS VIGOROUSLY**, and is highly **EXPLOSIVE**.
- Cannot exist as a **SINGLE ATOM**, but as a **MOLECULE (H<sub>2</sub>)**.







# Families of the Periodic Table...

## 4. Chalcogens (Group 16):

- Contains: *O, S, Se, etc.*
- **QUITE REACTIVE**, not as reactive as **HALOGENS**.
- Have similar **STRUCTURE** to **HALOGENS**, but have only **6 VALENCE ELECTRONS**.

Periodic Table of the Elements

© www.elementsdatabase.com

Legend:

- hydrogen
- alkali metals
- alkali earth metals
- transition metals
- poor metals
- nonmetals
- noble gases
- rare earth metals

|    |    |    |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
|----|----|----|-----|-----|-----|-----|-----|-----|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| 1  |    |    |     |     |     |     |     |     |     |    |    |    |    |    |    |    | 2  |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| H  |    |    |     |     |     |     |     |     |     |    |    |    |    |    |    |    | He |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| 3  | 4  |    |     |     |     |     |     |     |     |    |    |    |    |    |    | 10 |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Li | Be |    |     |     |     |     |     |     |     |    |    |    |    |    |    | Ne |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| 11 | 12 |    |     |     |     |     |     |     |     |    |    |    |    |    |    | 18 |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Na | Mg |    |     |     |     |     |     |     |     |    |    |    |    |    |    | Ar |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| 19 | 20 | 21 | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| K  | Ca | Sc | Ti  | V   | Cr  | Mn  | Fe  | Co  | Ni  | Cu | Zn | Ga | Ge | As | Se | Br | Kr |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| 37 | 38 | 39 | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Rb | Sr | Y  | Zr  | Nb  | Mo  | Tc  | Ru  | Rh  | Pd  | Ag | Cd | In | Sn | Sb | Te | I  | Xe |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| 55 | 56 | 57 | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Cs | Ba | La | Hf  | Ta  | W   | Re  | Os  | Ir  | Pt  | Au | Hg | Tl | Pb | Bi | Po | At | Rn |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| 87 | 88 | 89 | 104 | 105 | 106 | 107 | 108 | 109 | 110 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
| Fr | Ra | Ac | Unq | Unp | Unh | Uns | Uno | Une | Unn |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |     |     |     |     |
|    |    |    |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68  | 69  | 70  | 71  |
|    |    |    |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    | Ce | Pr | Nd | Pm | Sm | Eu | Gd | Tb | Dy | Ho | Er  | Tm  | Yb  | Lu  |
|    |    |    |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
|    |    |    |     |     |     |     |     |     |     |    |    |    |    |    |    |    |    | Th | Pa | U  | Np | Pu | Am | Cm | Bk | Cf | Es | Fm  | Md  | No  | Lr  |





# Families of the Periodic Table...

Lets organize the some of the information:

| Family                | Column | = | Number of Valence Electrons | Reactivity |
|-----------------------|--------|---|-----------------------------|------------|
| Hydrogen              | 1      | = | 1                           | Very       |
| Alkali Metals         | 1      | = | 1                           | Very       |
| Alkaline Earth Metals | 2      | = | 2                           | Fairly     |
| Chalcogens            | 6      | = | 6                           | Fairly     |
| Halogens              | 7      | = | 7                           | Very       |
| Noble Gases           | 8      | = | full shell (8)              | Not        |

Inert

**Question:** \*

How does the number of valence electrons relate to reactivity?

The closer to filling the valence shell, the more reactive