

The Periodic Table

History

- Russian scientist Dmitri Mendeleev taught chemistry in terms of properties.
- Mid 1800 - molar masses of elements were known.
- Wrote down the elements in order of increasing mass.
- Found a pattern of repeating properties.

Mendeleev's Periodic Table

TABELLE II

| REIHEN | GRUPPE I. — R ² O | GRUPPE II. — RO | GRUPPE III. — R ² O ³ | GRUPPE IV. RH ⁴ RO ² | GRUPPE V. RH ³ R ² O ⁵ | GRUPPE VI. RH ² RO ³ | GRUPPE VII. RH R ² O ⁷ | GRUPPE VIII. — RO ⁴ |
|--------|------------------------------------|-----------------------|---|--|---|--|--|--------------------------------------|
| 1 | H=1 | | | | | | | |
| 2 | Li=7 | Be=9,4 | B=11 | C=12 | N=14 | O=16 | F=19 | |
| 3 | Na=23 | Mg=24 | Al=27,3 | Si=28 | P=31 | S=32 | Cl=35,5 | |
| 4 | K=39 | Cd=40 | —=44 | Ti=48 | V=51 | Cr=52 | Mn=55 | Fe=56, Co=59, Ni=59, Cu=63. |
| 5 | (Cu=63) | Zn=65 | —=68 | —=72 | As=75 | Se=78 | Br=80 | |
| 6 | Rb=85 | Sr=87 | ?Yt=88 | Zr=90 | Nb=94 | Mo=96 | —=100 | Ru=104, Rh=104, Pd=106, Ag=108. |
| 7 | (Ag=108) | Cd=112 | In=113 | Sn=118 | Sb=122 | Te=125 | J=127 | |
| 8 | Cs=133 | Ba=137 | ?Di=138 | ?Ce=140 | — | — | — | — |
| 9 | (—) | — | — | — | — | — | — | — |
| 10 | — | — | ?Er=178 | ?La=180 | Ta=182 | W=184 | — | Os=195, Ir=197, Pt=198, Au=199. |
| 11 | (Au=199) | Hg=200 | Tl=204 | Pb=207 | Bi=208 | — | — | — |
| 12 | — | — | — | Th=231 | — | U=240 | — | — |

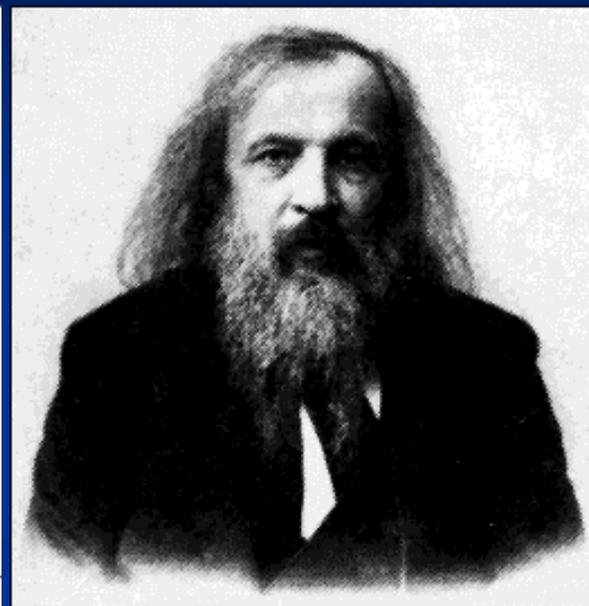


Figure 2.5 Dmitri Mendeleev's 1872 periodic table. The spaces marked with blank lines represent elements that Mendeleev deduced existed but were unknown at the time, so he left places for them in the table. The symbols at the top of the columns (e.g., R²O and RH⁴) are molecular formulas written in the style of the 19th century.

Mendeleev's Table

- Grouped elements in columns by similar properties in order of increasing atomic mass.
- Found some inconsistencies - felt that the properties were more important than the mass, so switched order.
- Found some gaps.
- Must be undiscovered elements.
- Predicted their properties before they were found.

The modern table

- Elements are still grouped by properties.
- Similar properties are in the same column.
- Order is in increasing atomic number.
- Added a column of elements Mendeleev didn't know about.
- The noble gases weren't found because they didn't react with anything.

The Periodic Table

| | | | | | | | | | | | | | | | | | | |
|-----------------------|----------|-------------------|-----------|------------|------------|------------|------------|------------|------------|------------|------------|----------|----------|----------|----------|----------|-------------|----------|
| Alkaline earth metals | | | | | | | | | | | | Halogens | | | | | Noble gases | |
| 1A | 2A | Transition metals | | | | | | | | | | 3A | 4A | 5A | 6A | 7A | 8A | |
| 1 H | 2 He | | | | | | | | | | | 13 3A | 14 4A | 15 5A | 16 6A | 17 7A | 18 8A | |
| 3 Li | 4 Be | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 5 B | 6 C | 7 N | 8 O | 9 F | 10 Ne | |
| 11 Na | 12 Mg | Transition metals | | | | | | | | | | 13 Al | 14 Si | 15 P | 16 S | 17 Cl | 18 Ar | |
| Alkali metals | 19 K | 20 Ca | 21 Sc | 22 Ti | 23 V | 24 Cr | 25 Mn | 26 Fe | 27 Co | 28 Ni | 29 Cu | 30 Zn | 31 Ga | 32 Ge | 33 As | 34 Se | 35 Br | 36 Kr |
| | 37 Rb | 38 Sr | 39 Y | 40 Zr | 41 Nb | 42 Mo | 43 Tc | 44 Ru | 45 Rh | 46 Pd | 47 Ag | 48 Cd | 49 In | 50 Sn | 51 Sb | 52 Te | 53 I | 54 Xe |
| | 55 Cs | 56 Ba | 57 La* | 72 Hf | 73 Ta | 74 W | 75 Re | 76 Os | 77 Ir | 78 Pt | 79 Au | 80 Hg | 81 Tl | 82 Pb | 83 Bi | 84 Po | 85 At | 86 Rn |
| | 87 Fr | 88 Ra | 89 Ac† | 104 Unq | 105 Unp | 106 Unh | 107 Uns | 108 Uno | 109 Une | 110 Uun | 111 Uuu | | | | | | | |

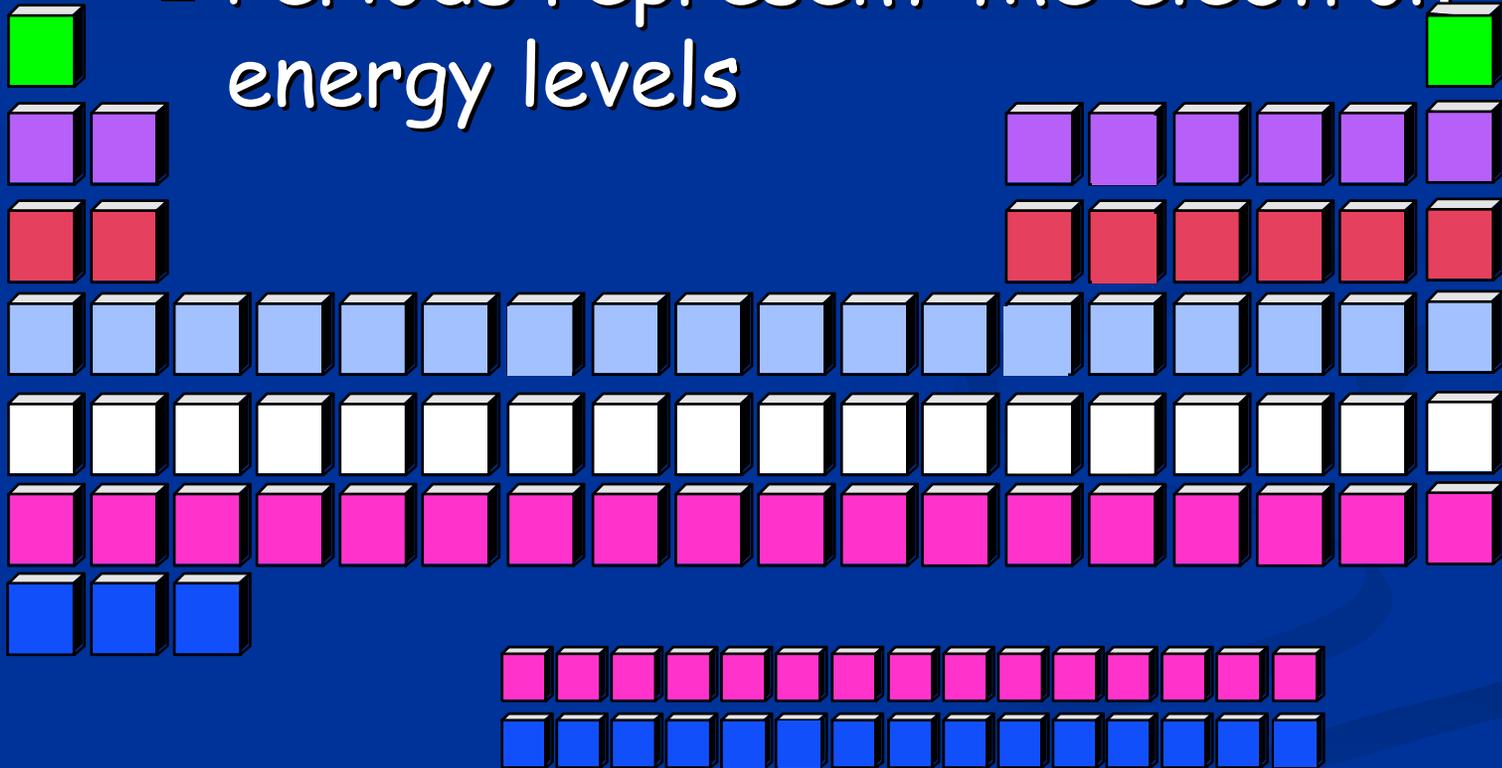
*Lanthanides

| | | | | | | | | | | | | | |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 58 Ce | 59 Pr | 60 Nd | 61 Pm | 62 Sm | 63 Eu | 64 Gd | 65 Tb | 66 Dy | 67 Ho | 68 Er | 69 Tm | 70 Yb | 71 Lu |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|

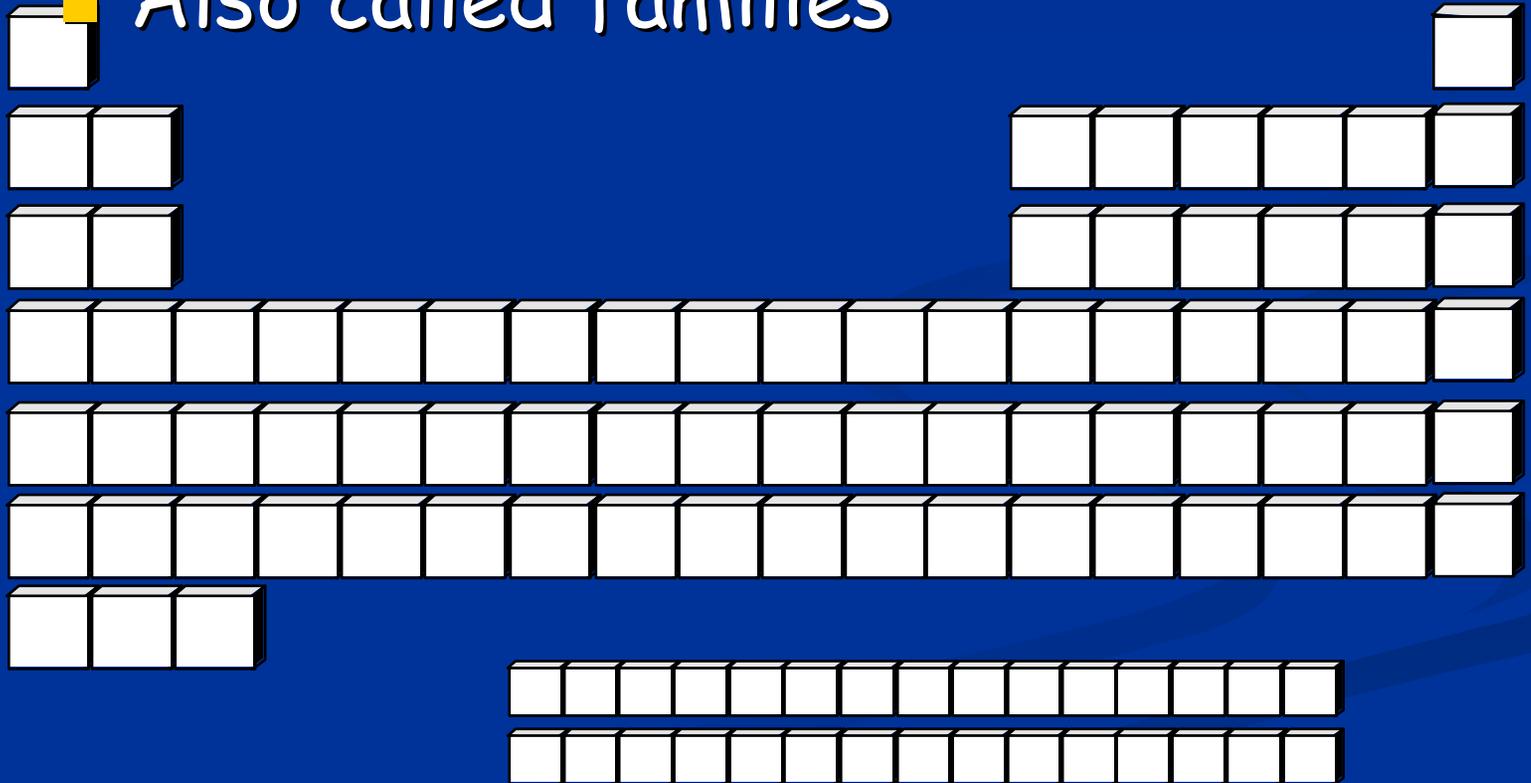
† Actinides

| | | | | | | | | | | | | | |
|----------|----------|---------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|
| 90 Th | 91 Pa | 92 U | 93 Np | 94 Pu | 95 Am | 96 Cm | 97 Bk | 98 Cf | 99 Es | 100 Fm | 101 Md | 102 No | 103 Lr |
|----------|----------|---------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|

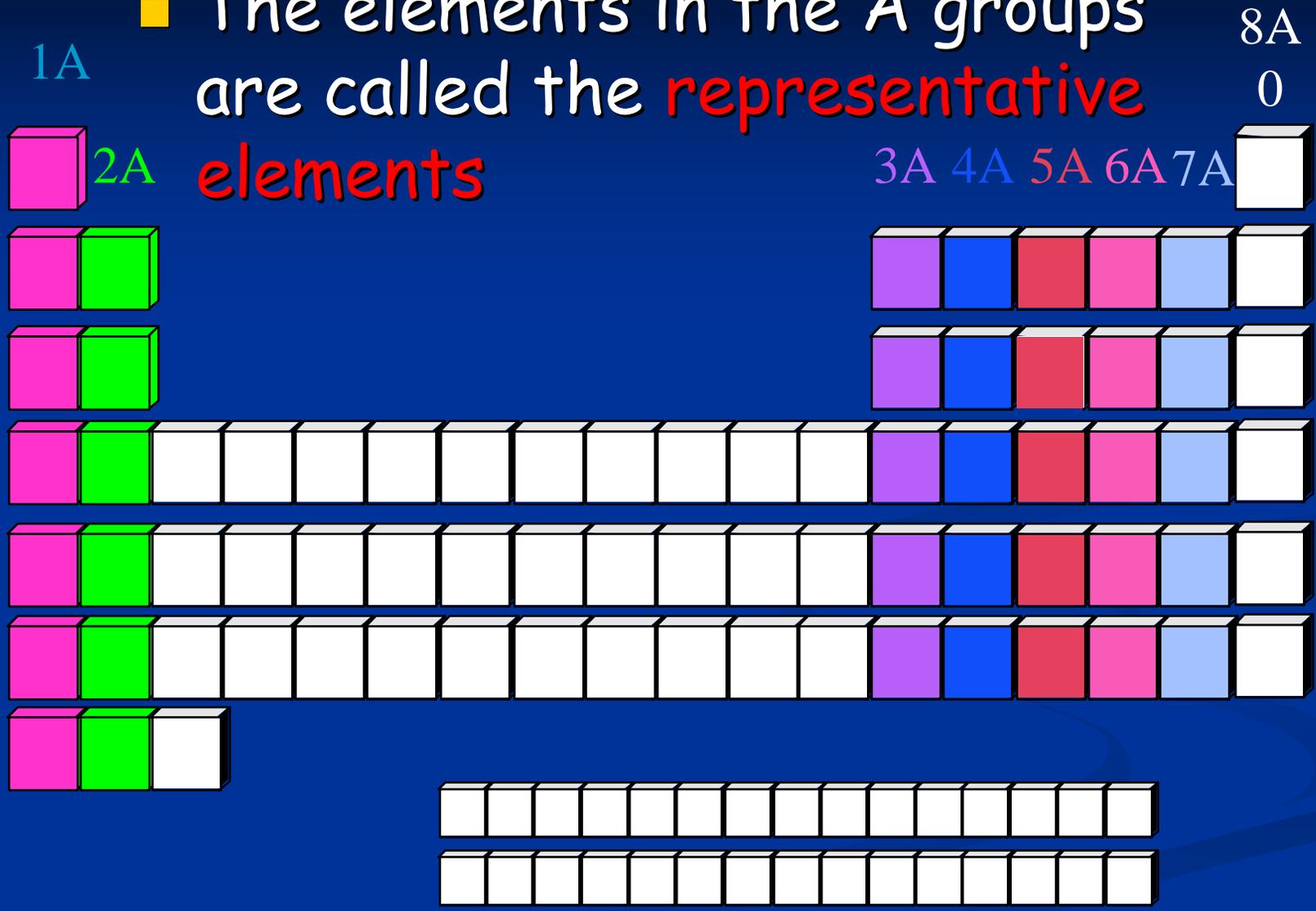
- Horizontal rows are called periods
- There are 7 periods
- Periods represent the electron energy levels



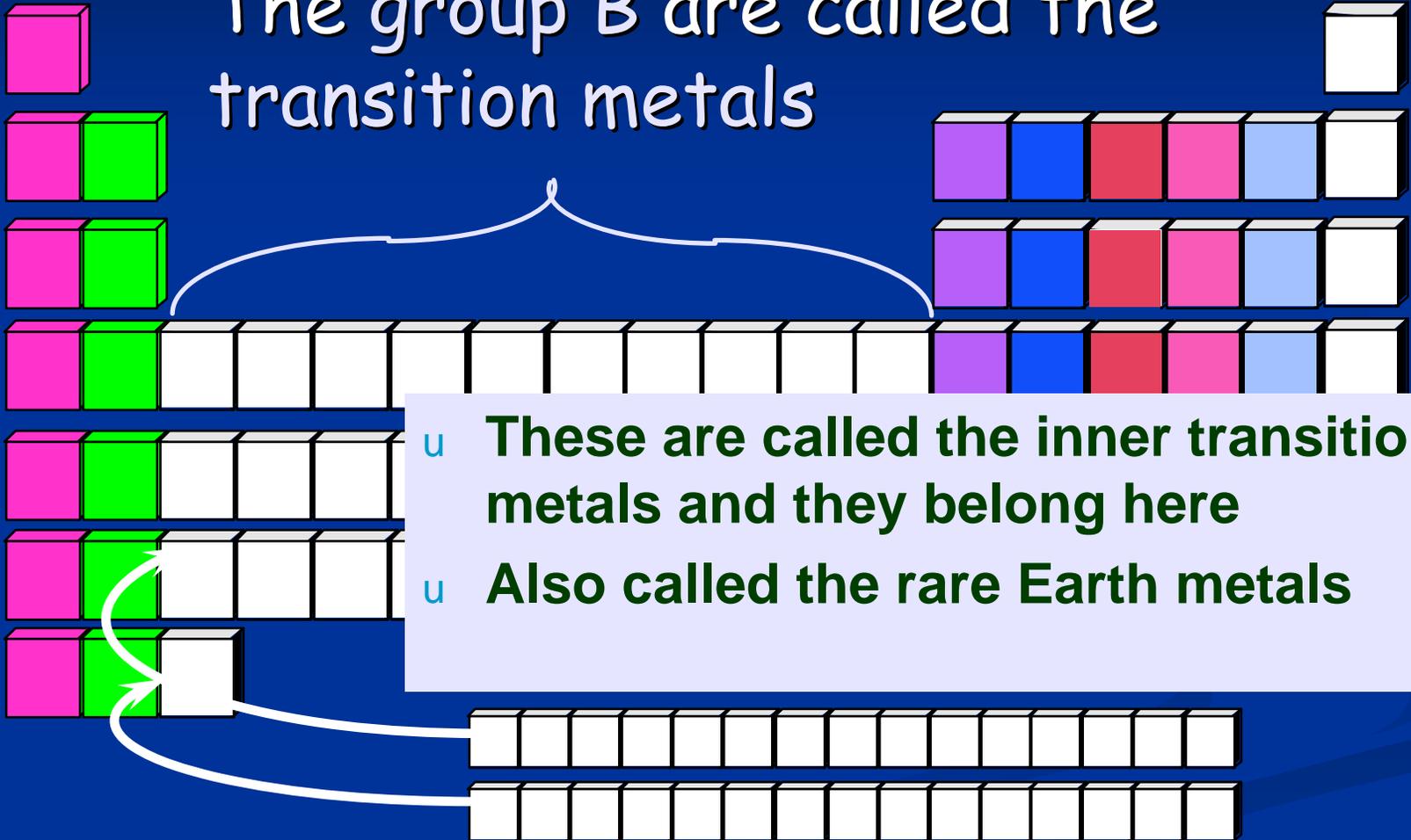
- Elements are placed in columns by similar properties.
- Vertical columns are called groups
- Also called families



- The elements in the A groups are called the **representative elements**



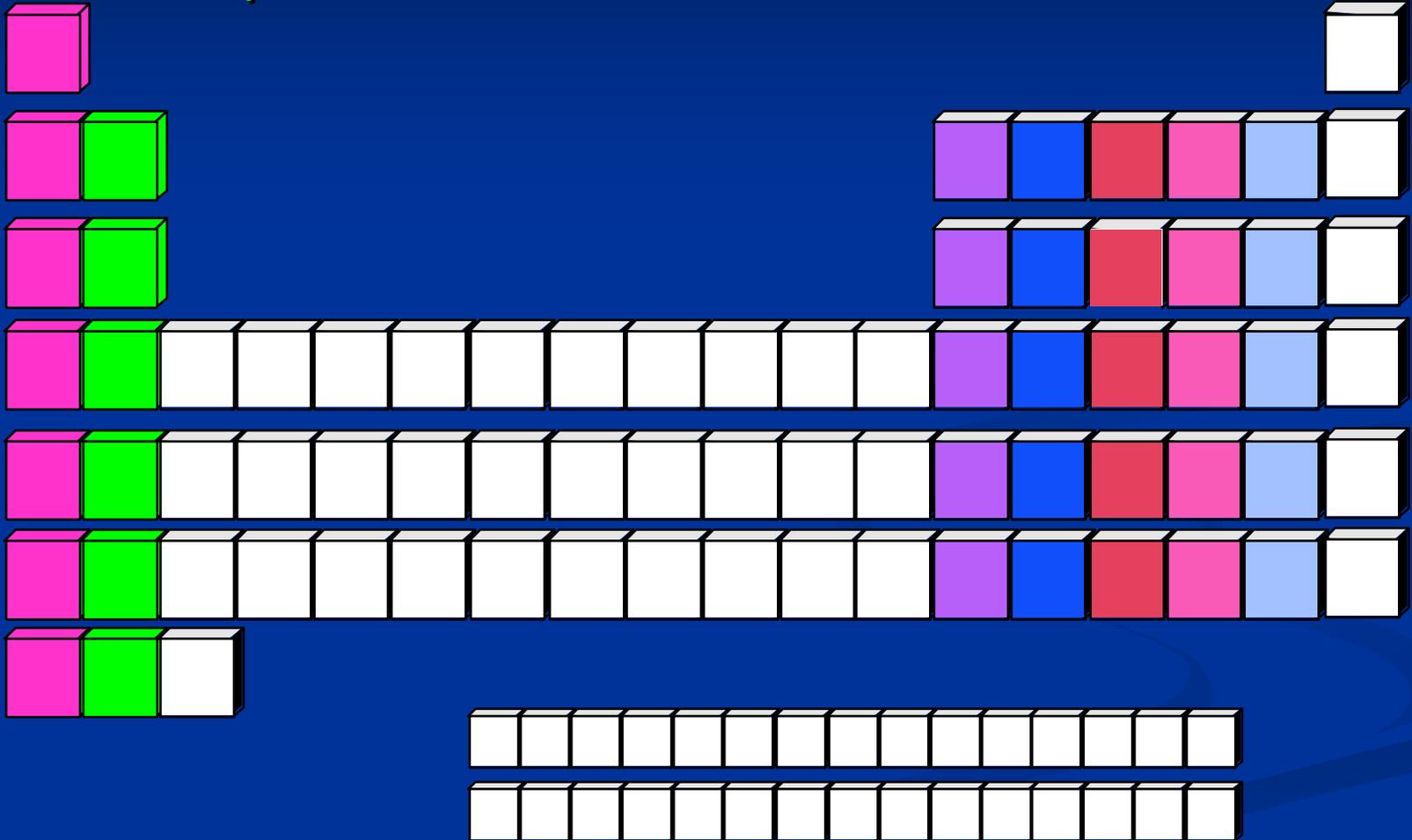
The group B are called the transition metals



u These are called the inner transition metals and they belong here

u Also called the rare Earth metals

- Group 1A are the alkali metals
- Group 2A are the alkaline earth metals



Alkali Metals

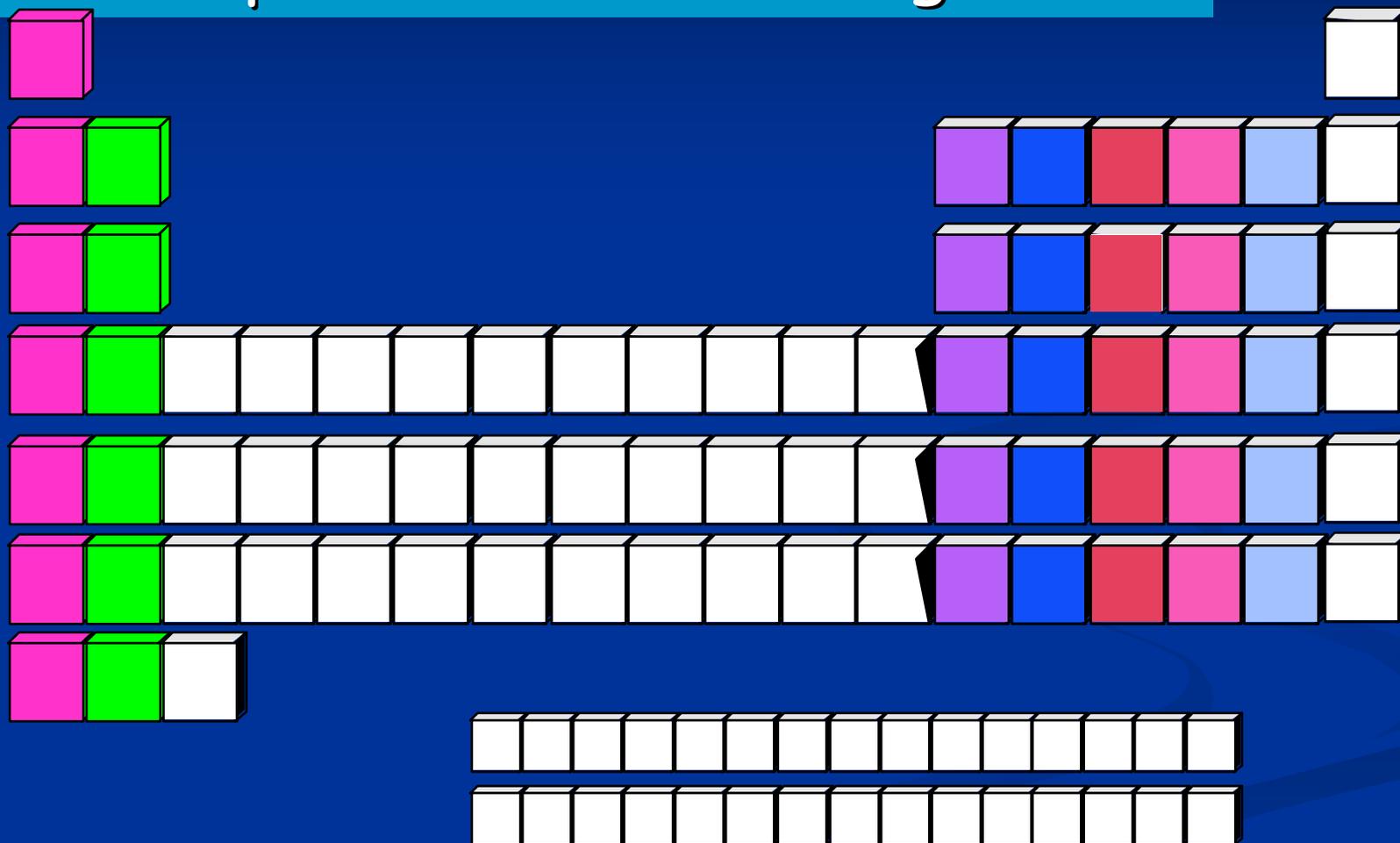
- Very reactive
- Not found alone in nature because they react to form compounds
- Have one valence electron
- Easily lose their valence electron to form a **+1 ion**

Alkaline Earth Metals

- Less reactive than Alkali metals family
- Have **two** valence electrons
- Lose their valence electrons to form ions with a +2 charge

■ Group 7A is called the Halogens

■ Group 8A are the noble gases



Halogen Family

- Very reactive
- Have 7 valence electrons
- They gain one electron to form a -1 ion

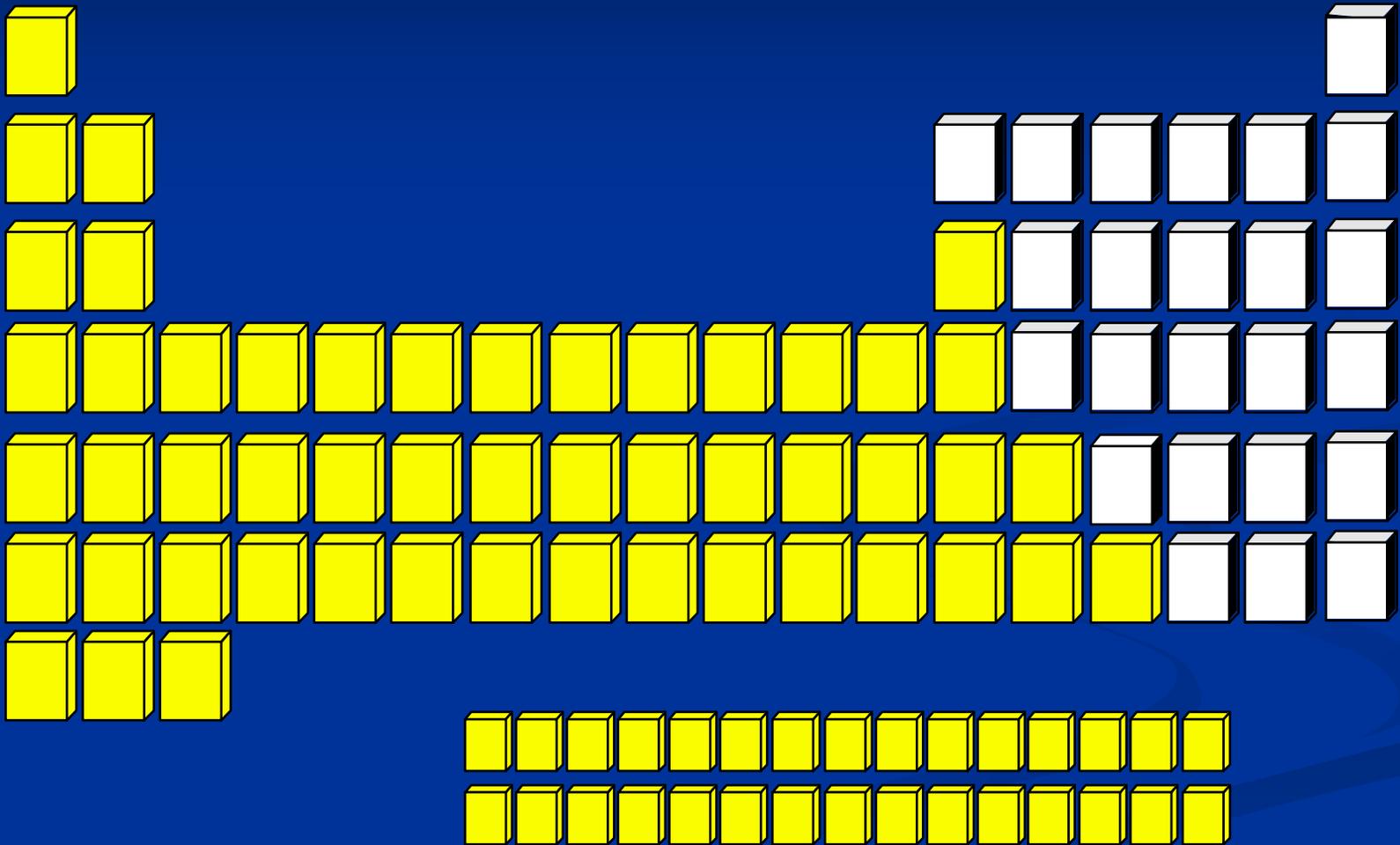
Noble Gases

- Do not react
- Will not form compounds (except under very rare circumstances)
- They are **inert gases** because inert means non-reactive

Metals and Nonmetals

- A zigzag line separates the metals from the nonmetals
- Lanthanide and Actinide Series elements (ones at the bottom) are **Metals**
- Metalloids, which straddle the line, are considered non-metals

Metals



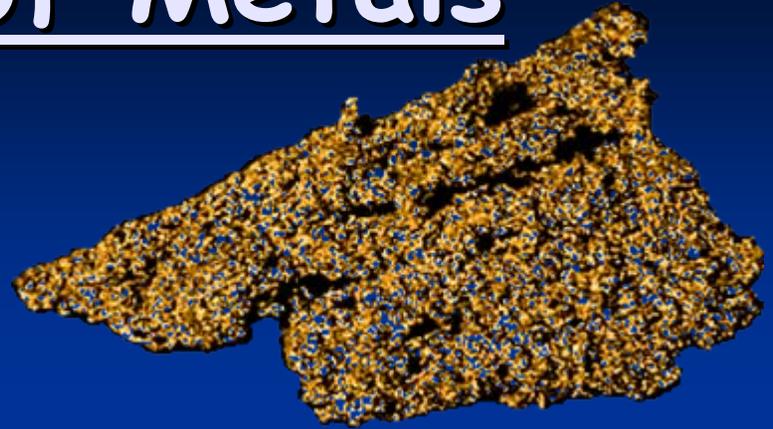
Properties of Metals

- ❑ Metals are good conductors of heat and electricity
- ❑ Metals are malleable
- ❑ Metals are ductile
- ❑ Metals have high tensile strength
- ❑ Metals have luster



Examples of Metals

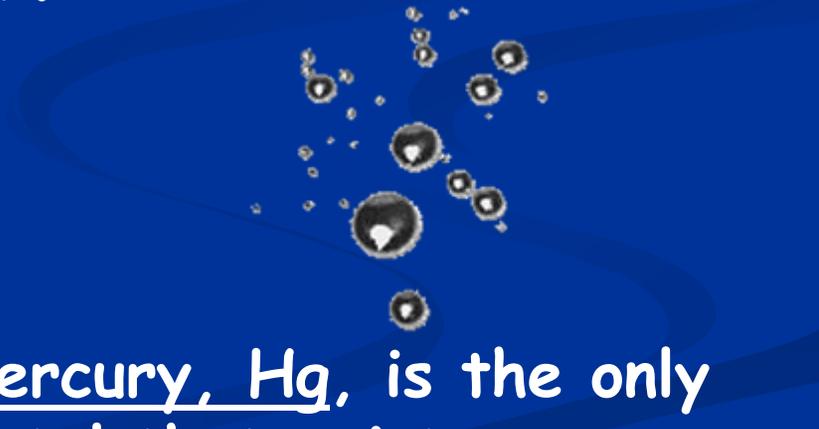
Potassium, K reacts with water and must be stored in kerosene



Copper, Cu, is a relatively soft metal, and a very good electrical conductor.



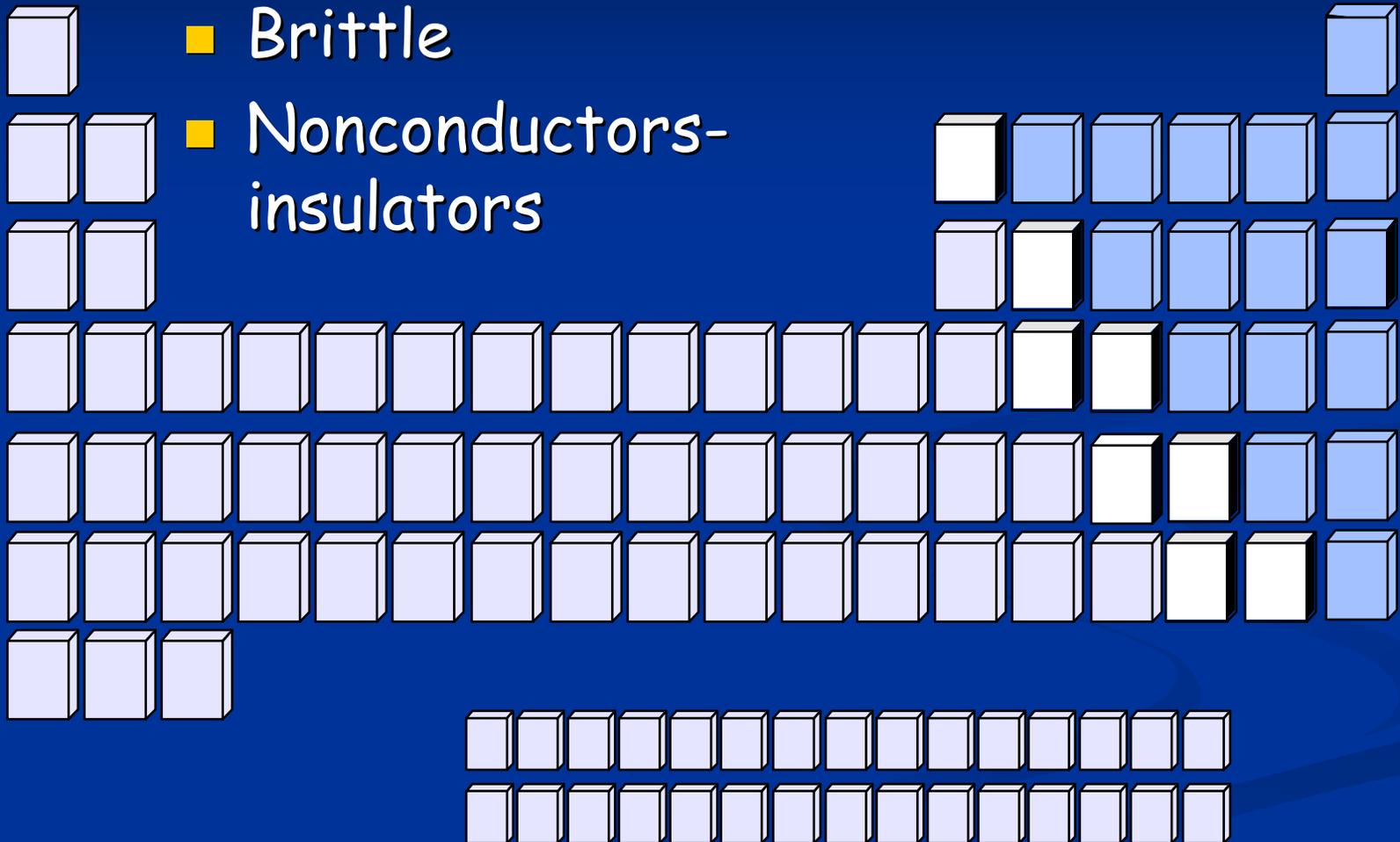
Zinc, Zn, is more stable than potassium



Mercury, Hg, is the only metal that exists as a liquid at room temperature

Non-metals

- Dull
- Brittle
- Nonconductors-insulators



Properties of Nonmetals...

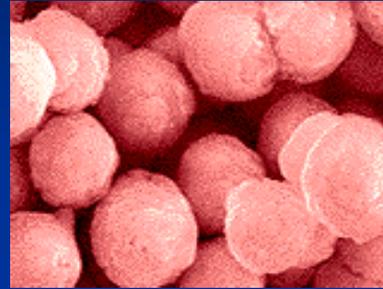


Carbon, the graphite in “pencil lead” is a great example of a nonmetallic element.

- Nonmetals are poor conductors of heat and electricity
- Nonmetals tend to be brittle
- Many nonmetals are gases at room temperature

Examples of Nonmetals

Sulfur, S, was once known as "brimstone"

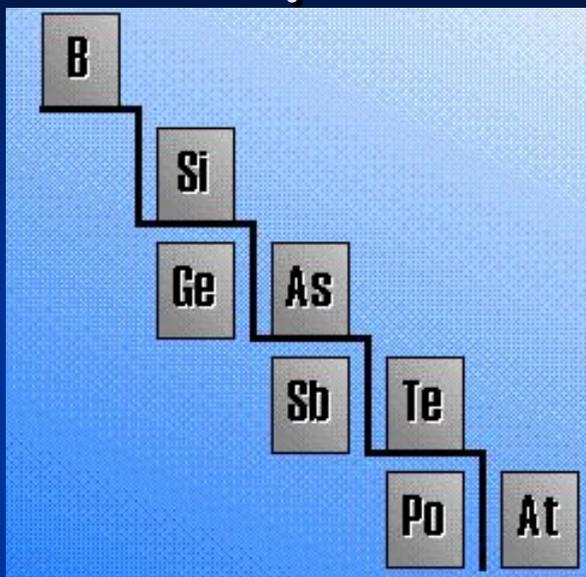


Microspheres of phosphorus, P, a reactive nonmetal

Graphite is not the only pure form of carbon, C. Diamond is also carbon; the color comes from impurities caught within the crystal structure



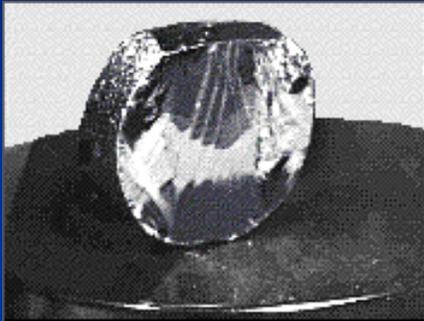
Properties of Metalloids



Metalloids straddle the border between metals and nonmetals on the periodic table.

- ❖ They have properties of both metals and nonmetals.
- ❖ Metalloids are more brittle than metals, less brittle than most nonmetallic solids
- ❖ Metalloids are semiconductors of electricity
- ❖ Some metalloids possess metallic luster

Silicon, Si - A Metalloid



- ❑ Silicon has metallic luster
- ❑ Silicon is brittle like a nonmetal
- ❑ Silicon is a semiconductor of electricity

Other metalloids include:

- Boron, B
- Germanium, Ge
- Arsenic, As
- Antimony, Sb
- Tellurium, Te

