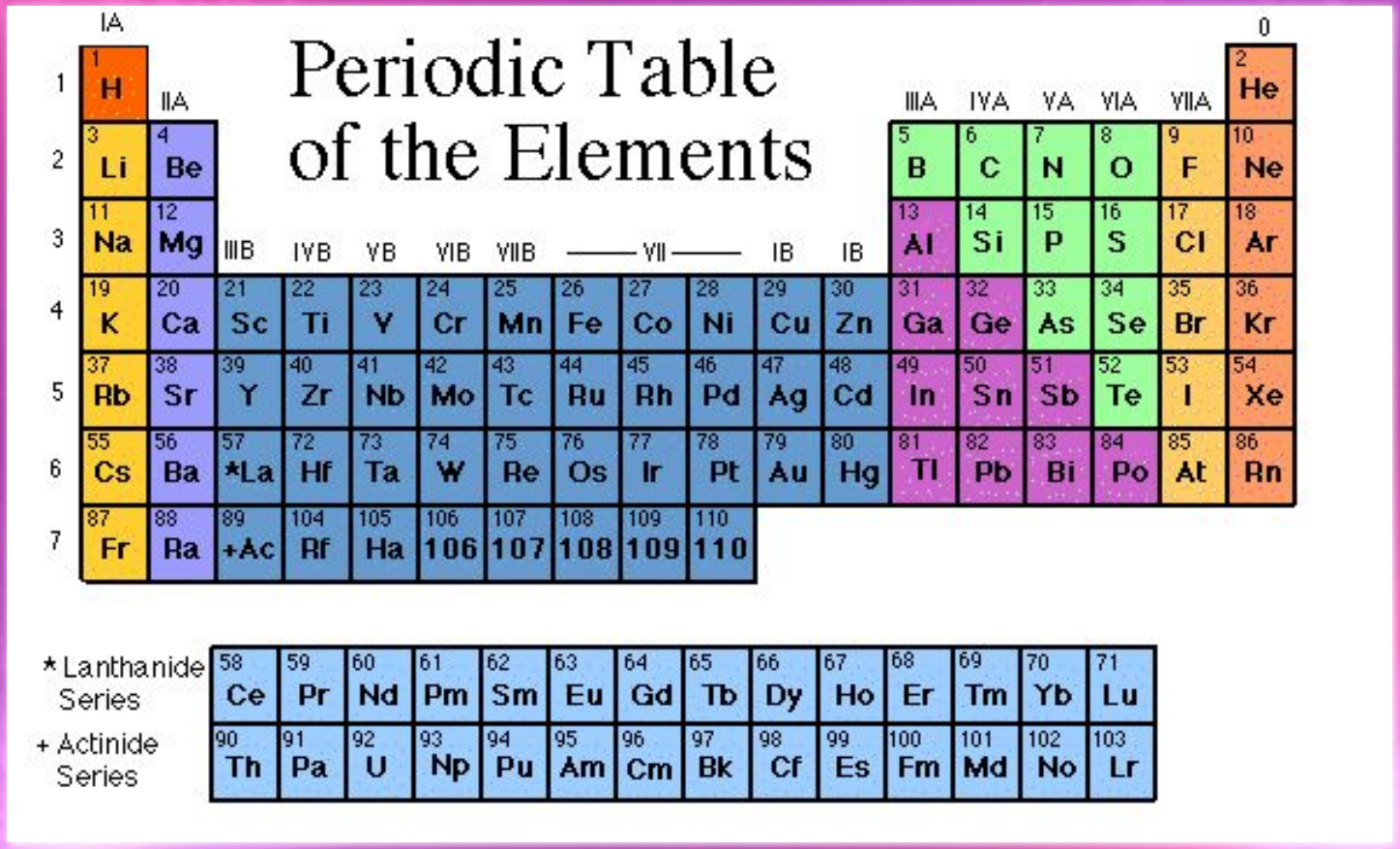
The Periodic Table of Elements



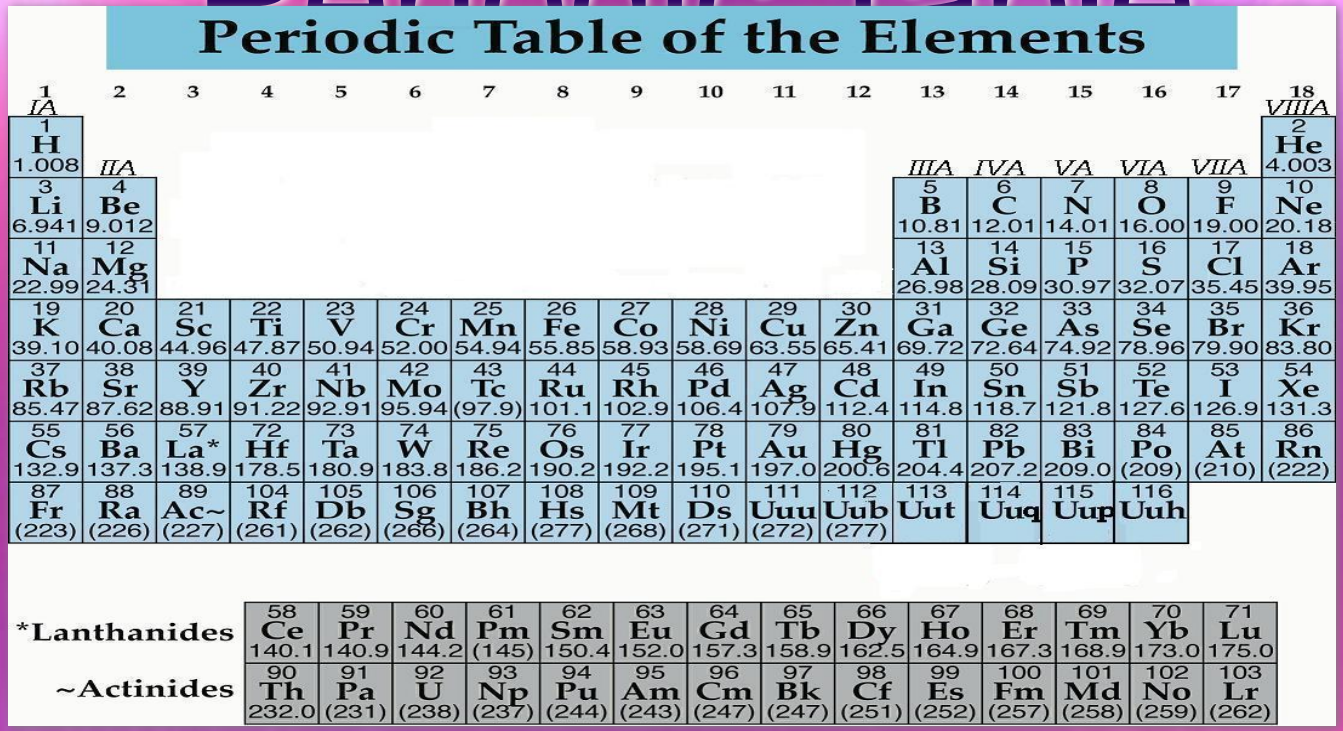
Elements

- Science has come along way since Aristotle's theory of Air, Water, Fire, and Earth.
- Scientists have identified **92 Natural elements**, and created about 28 others.

Elements

The elements, alone or in combinations, make up our bodies, our world, our sun, and in fact, the **entire universe**.

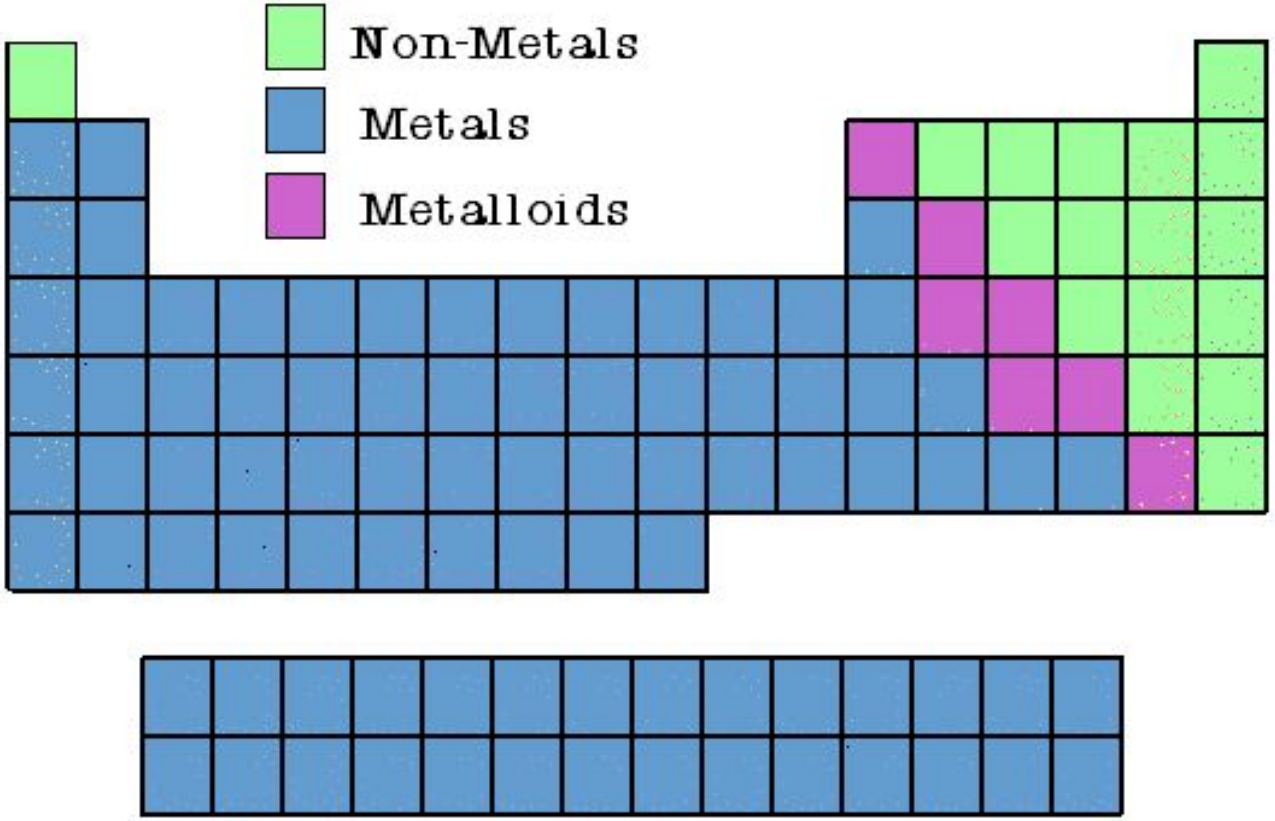
Periodic Table



- A great deal of information about an element can be gathered from its **position** on the period table.
- Understanding the organization and plan of the periodic table will help you obtain basic information about each of the 118 known elements.

Periodic Table

The elements of the periodic table can be divided into three main categories: Metals, Non-Metals, and Metalloids.



Metals


Ni
28
58.693
Nickel

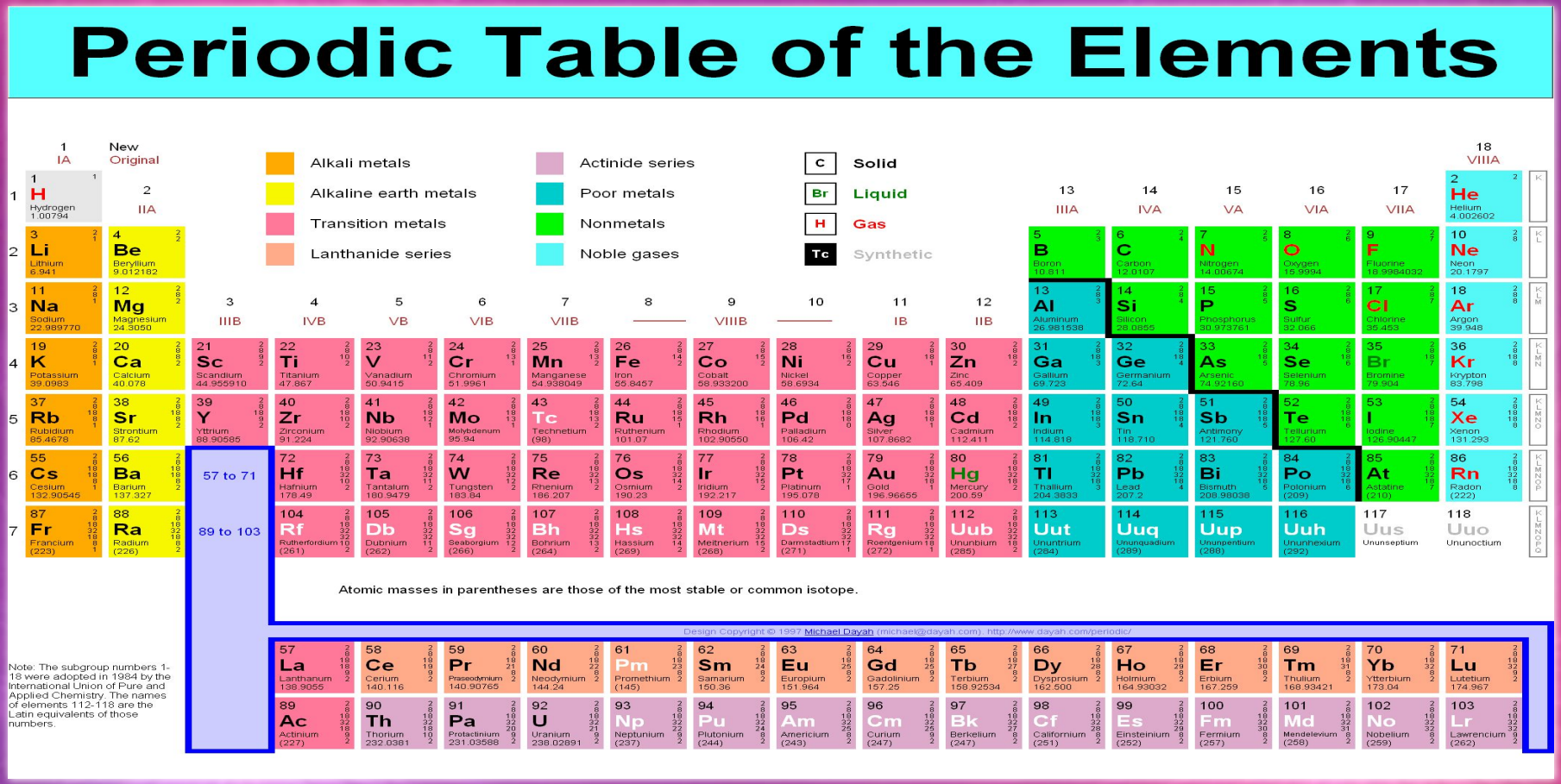

Rb
37
85.468
Rubidium


Au
79
196.97
Gold


Cu
29
63.546
Copper

Properties of Metals

Metals appear to the **left** of the **dark ziz-zag** line on the periodic table. Most metals are **solid** at room temperature.



Properties of Metals

Metals have **luster**. This means they are **shiny**

Properties of Metals

Ductile

metals can be drawn into wire.

Properties of Metals

Malleable

metals can be hammered into sheets

Properties of Metals

Metals have a high melting point. They are also very **dense**.

Properties of Metals

Conductors

Metals are good **conductors** of electricity and heat

Properties of Metals

A chemical property of metal is its reaction with water and oxygen. This results in **corrosion and rust**.

Metals

Uses, Properties and Structures and Modifying Metals

- Metals can be seen all around us
- We use metals because they have many useful properties
- Can you name some properties of metals that make them useful for

1. Electrical wires
2. Frames for houses
3. Taps

Metals (notes)

- Most elements are metals. 88 elements to the left of the stairstep line are metals or metal like elements.

Physical Properties of Metals:

- Metals have Lustre (shininess)
- Good conductors of heat and electricity
- High density (heavy for their size)
- High melting point
- Ductile (most metals can be drawn out into thin wires)
- Malleable (most metals can be hammered into thin sheets)

Chemical Properties of Metals:

- Easily lose electrons
- Corrode easily. Corrosion is a gradual wearing away. (Example: silver tarnishing and iron rusting)

Exceptions to the rule

- Mercury is liquid at room temperature
- Alkali metals (group 1) can be cut with a knife at room temperature
- Looking at Table 5.1 pg 79 where would you draw the line between metals and non metals

- How would you test for hardness?
- Electrical conductivity?
- Heat conductivity?

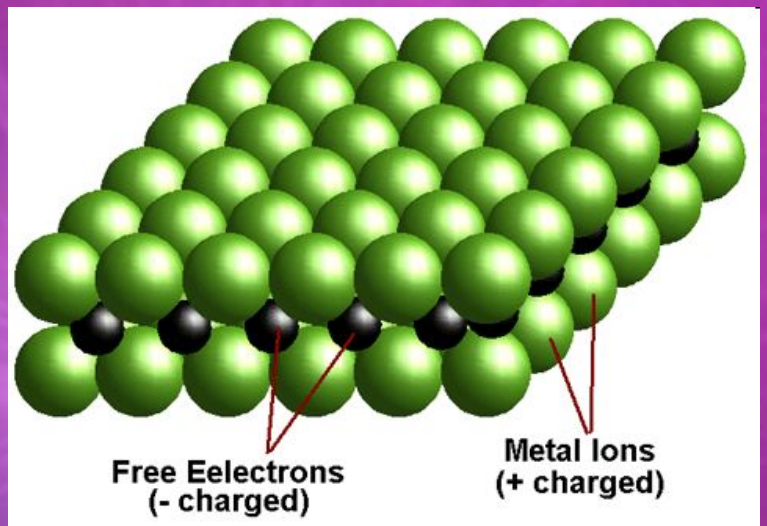
Properties and Structures of Metals

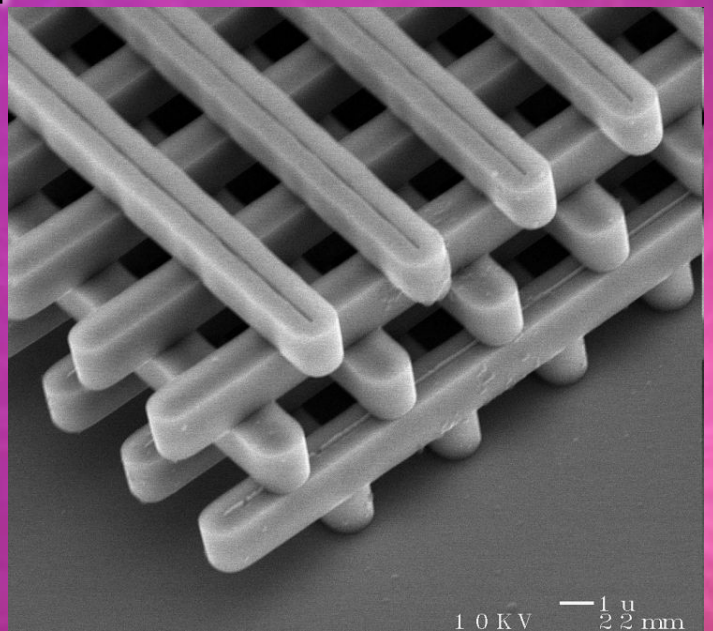
Metallic bonding model

- In a solid sample of a metal:

1. Positive ions are arranged in a closely packed structure. This is called a regular three dimensional lattice of positive ions.

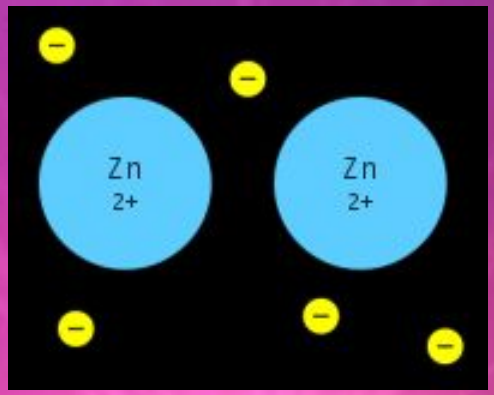
- The ions occupy fixed positions in a lattice





Metallic Bonding Model

2. The Outermost electrons (valence electrons) of metals wander freely through metallic lattice. These are called **delocalised electrons**.



- Metal consists of cations held together by negatively-charged electron "glue."
- **delocalised electrons** are not associated with a single atom or to a bond.

Metallic Bonding Model

3. The ions in the lattice are held together by electrostatic forces and delocalised electrons

Electrostatic forces are the forces between particles that are caused by their electric charges

This attraction extends throughout the lattice and is called **metallic bonding.**

Limitations to Metallic bonding model

- Some properties of metals cannot be explained by the metallic bonding

1.The range of melting points, densities

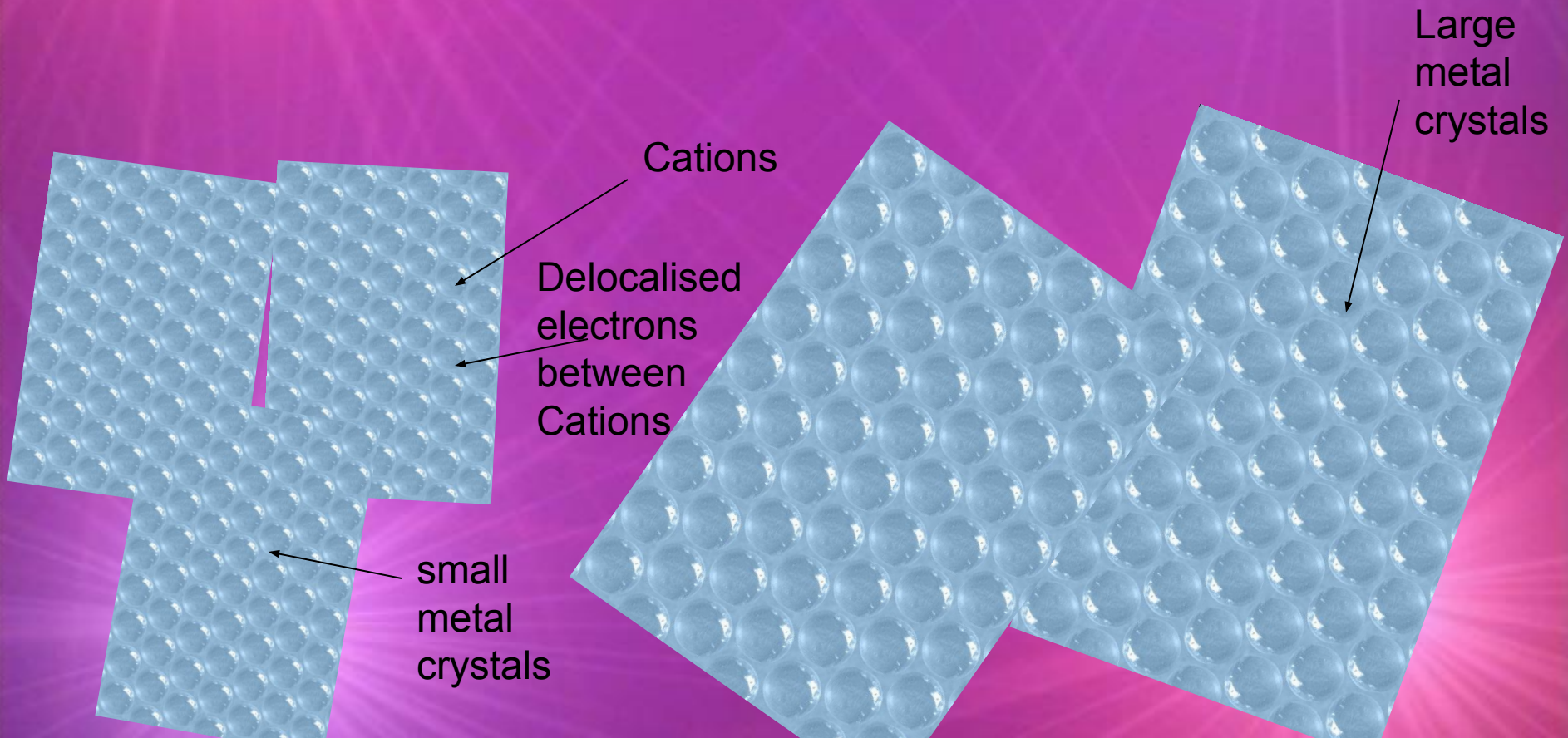
2. Magnetic nature of cobalt iron and nickel

3. Differences in electrical conductivity

4. Solubility in water and corrosion

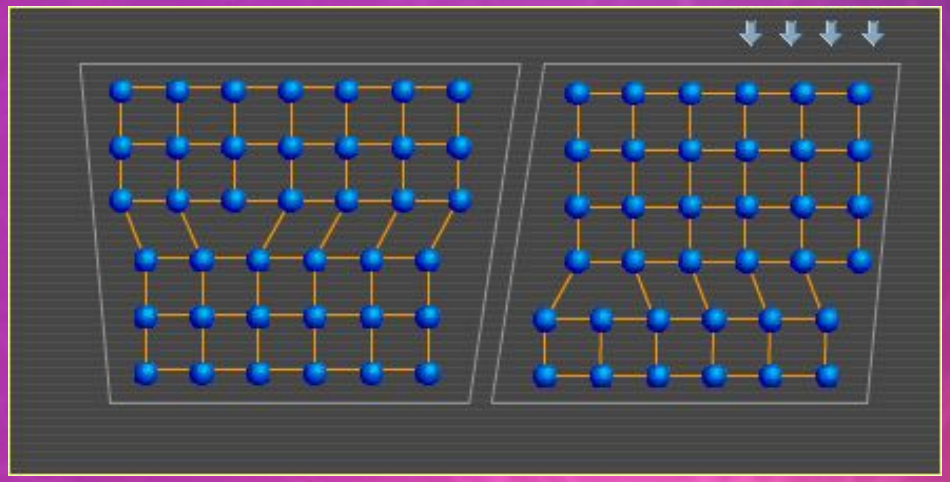
Metal crystals model

- Some of these limitations can be explained by the metal crystal model
- Metals form crystals, large or small

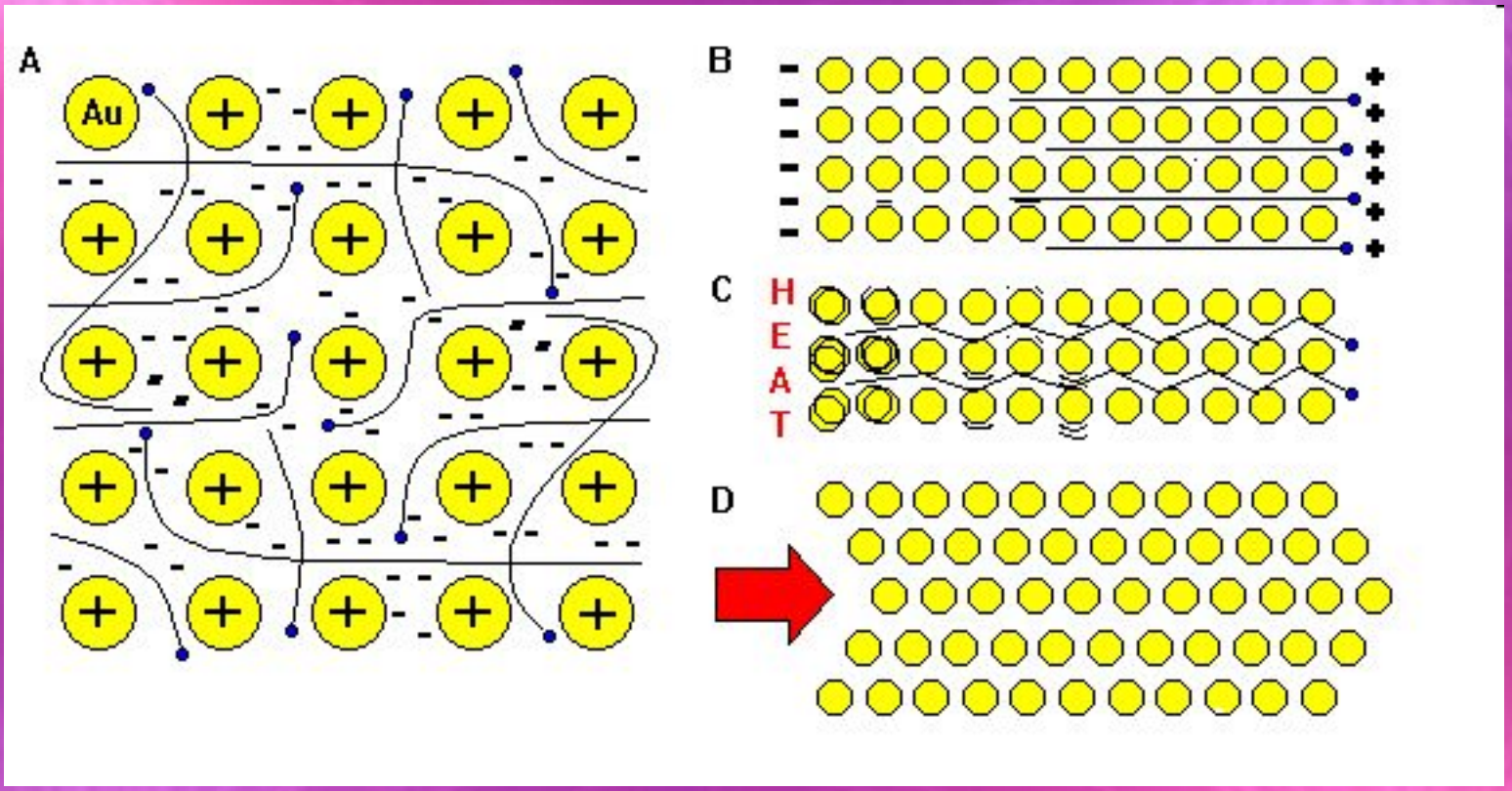


Piece of metal □metal crystals□ lattice of ions and electrons

- The Metallic bonding model refers the arrangement of particles (electrons etc) in one metal crystal.
- A piece of a metal consists of a large number of crystals.



- Where one crystal meets another the regular lattice is disrupted


A
Au
B
C
H
E
A
T
D

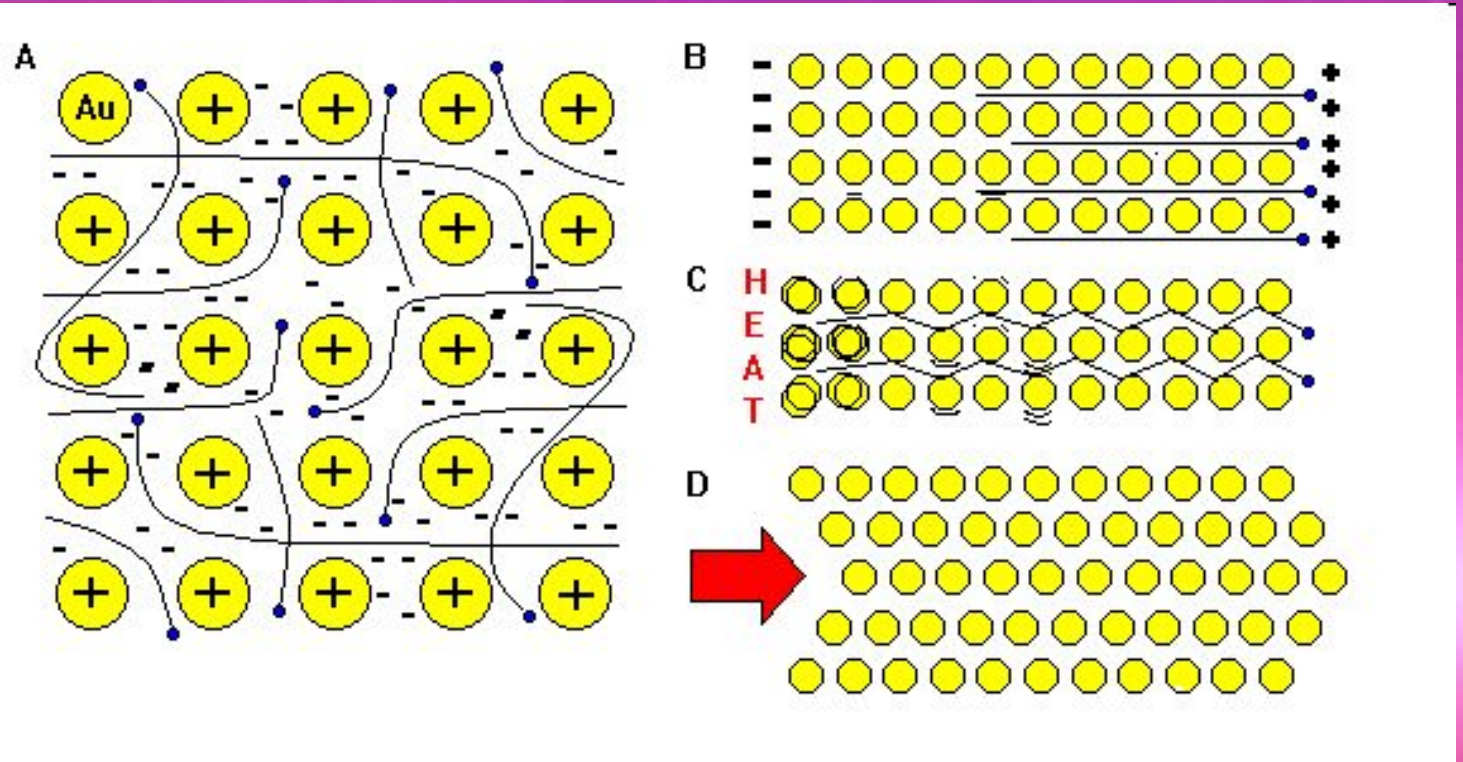
Explaining properties of metals

Why do metals have relatively high boiling points?

- The strong attraction (electrostatic forces) between the positive cations and delocalised electrons holds the metallic lattice together making it hard to loosen the bonds.

Why are metals good conductors of electricity and heat?

- Delocalised (free) electrons can move rapidly in response to electric fields and transmit heat, hence metals are a good conductors of electricity and



Why are metals malleable and ductile?

- The layers of atoms in metal are hard to pull apart because of the electrons holding them together, hence metals are tough.
- Individual atoms are not held to any other specific atoms, hence atoms slip easily past one another. Thus metals are ductile and malleable.

Why are metals hard?

- Strong electrostatic forces between the cations and electrons make it difficult to separate particles from one another
- Why are metals lustrous(shiny)?

- When light energy hits the delocalised electrons they absorb the energy and jump and energy level, when they go back down a level they release energy in the form of a photon hence the shininess

Modifying metals

Alloys, heat treatment and work hardening

Modifying Metals

- Few metals are used in their pure form
- Most metals need to be changed in some way so they can be used. This may include treating the metals and combining metals

Example: Iron is not hard enough by itself to be used so we use steel.

Steel is made by mixing iron with about 2% carbon

A: Alloys

- Properties of metals can be significantly altered by adding other substances, usually a metal or carbon.
- The substances are melted together and mixed then allowed to cool. This is called an **alloy.**
- Note no chemical reaction has taken place it is just a mixing of two metals
- There are two types of alloys malleable and ductile

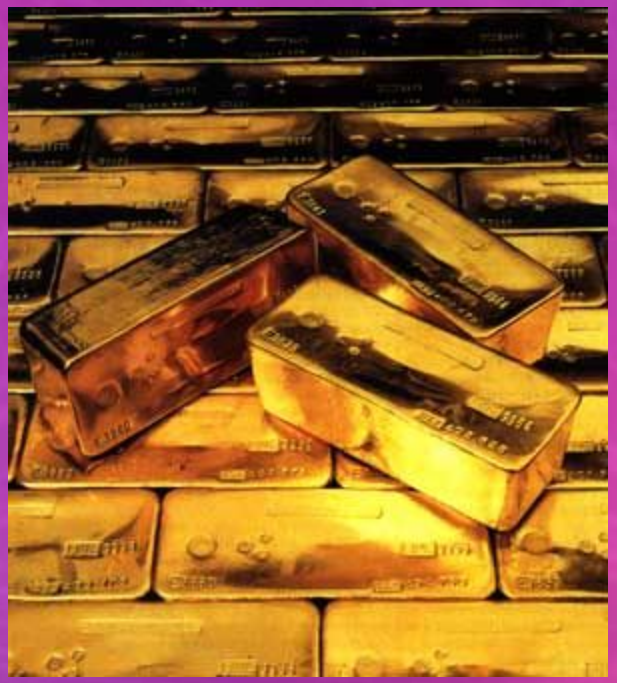
1. Substitutional alloys
2. interstatial

- White gold is an alloy of gold and at least one white metal, usually nickel or palladium
- Rose gold is a gold and copper alloy widely used in jewellery due to its reddish colour.
- Electrical transmission wires are made from an aluminium alloy

1. Substitutional alloys

- Substitutional alloys are made from elements that have similar chemical properties
- Example: Copper and Gold make rose gold

+



2. Interstitial alloys

- In interstitial alloys a small proportion of a smaller atoms is added to a metal
- Example: Carbon and iron make steel

+

B: Hardening Metals

- The way a metal is prepared can have a large impact on how it behaves
- Many metals are prepared in the liquid state and cooled. The rate at which it cools can have a significant effect on the properties of the solid

Arranging metal crystals

- Small metal crystals make the metal harder because the ions are less able to move
- Smaller crystals also means there is more disruption between crystals making them brittle (easy to break)
- Larger metal crystals make the metal soft