

The Periodic Table of Elements

Periodic Table of the Elements

1	IA																																0	
1	H																																	He
2	3	4																	5	6	7	8	9	10										
2	Li	Be																	B	C	N	O	F	Ne										
3	11	12																	13	14	15	16	17	18										
3	Na	Mg	III B	IV B	V B	VIB	VII B	— VII —				IB	IB	Al	Si	P	S	Cl	Ar															
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																
6	Cs	Ba	*La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																
7	87	88	89	104	105	106	107	108	109	110																								
7	Fr	Ra	+Ac	Rf	Ha	106	107	108	109	110																								

* Lanthanide Series

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

+ Actinide Series

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

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

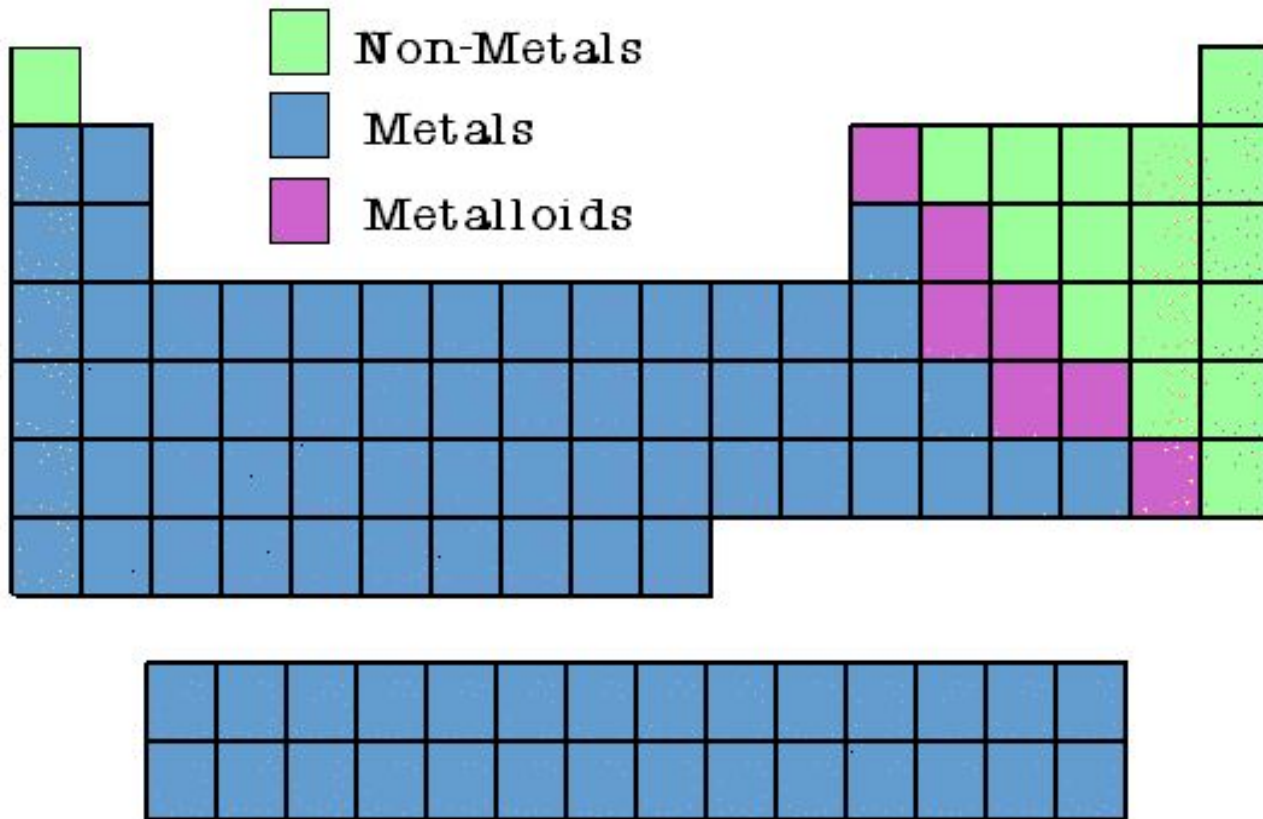
Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
IA											IIIA	IVA	VA	VIA	VIIA	VIIIA			
1 H 1.008											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18			
3 Li 6.941	4 Be 9.012											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95		
11 Na 22.99	12 Mg 24.31	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (97.9)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3		
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)		
87 Fr (223)	88 Ra (226)	89 Ac~ (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Uuu (272)	112 Uub (277)	113 Uut	114 Uuq	115 Uup	116 Uuh				
*Lanthanides		58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0				
~Actinides		90 Th 232.0	91 Pa (231)	92 U (238)	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)				

- A great deal of information about an element can be gathered from its **position** on the periodic 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

A small, irregular, silvery-white metal sample with a rough, crystalline surface, showing some darker spots and a slightly porous texture.

Rb 37
85.468



Rubidium

A small, rectangular, silvery-white metal sample with a highly reflective, crystalline surface, showing some internal grain structure and a slightly irregular shape.

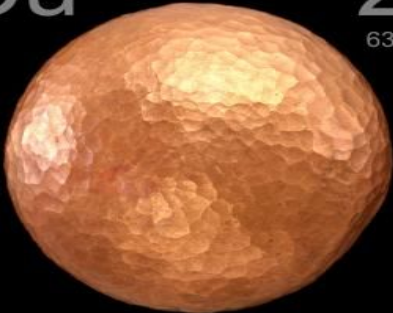
Au 79
196.97



Gold

A large, irregular, yellowish-gold metal sample with a highly reflective, crystalline surface, showing some internal grain structure and a slightly irregular shape.

Cu 29
63.546



Copper

A large, spherical, reddish-orange metal sample with a highly reflective, crystalline surface, showing some internal grain structure and a slightly irregular shape.

Properties of Metals

Metals have
luster. This
means they are
shiny



Properties of Metals

Ductile

metals can be drawn into wire.



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Properties of Metals



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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 staircase 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



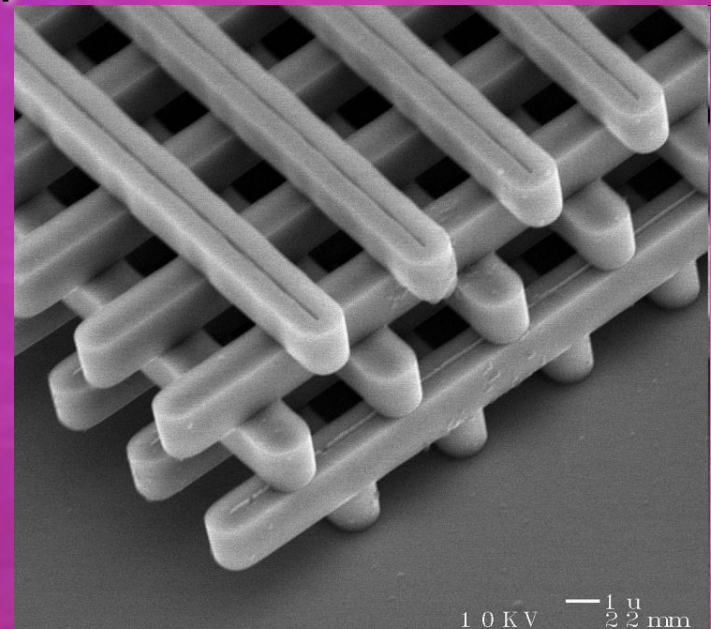
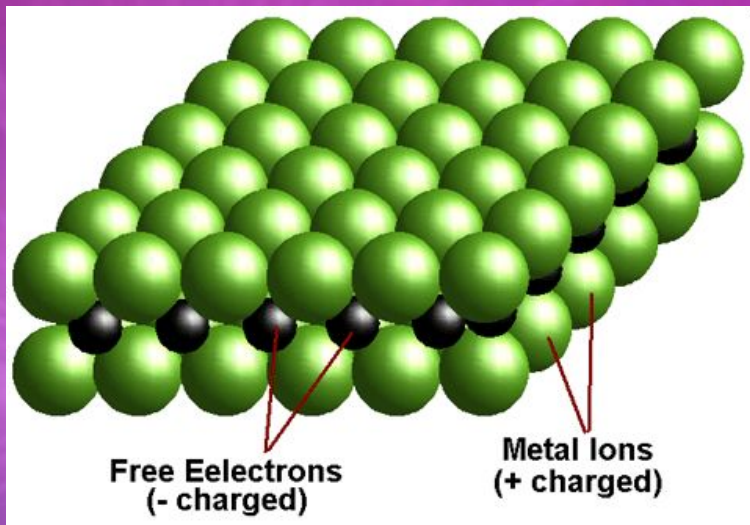
- Mercury is liquid at room temperature
- Alkali metals (group 1) can be cut with a knife at room temperature
- Looking at Table 5.1 pg 79 where would you draw the line between metals and non metals

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

Properties and Structures of Metals

Metallic bonding model

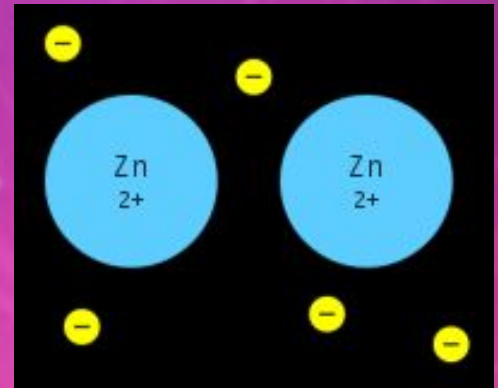
- In a solid sample of a metal:
 1. Positive ions are arranged in a closely packed structure. This is called a regular three dimensional lattice of positive ions.
- The ions occupy fixed positions in a lattice



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

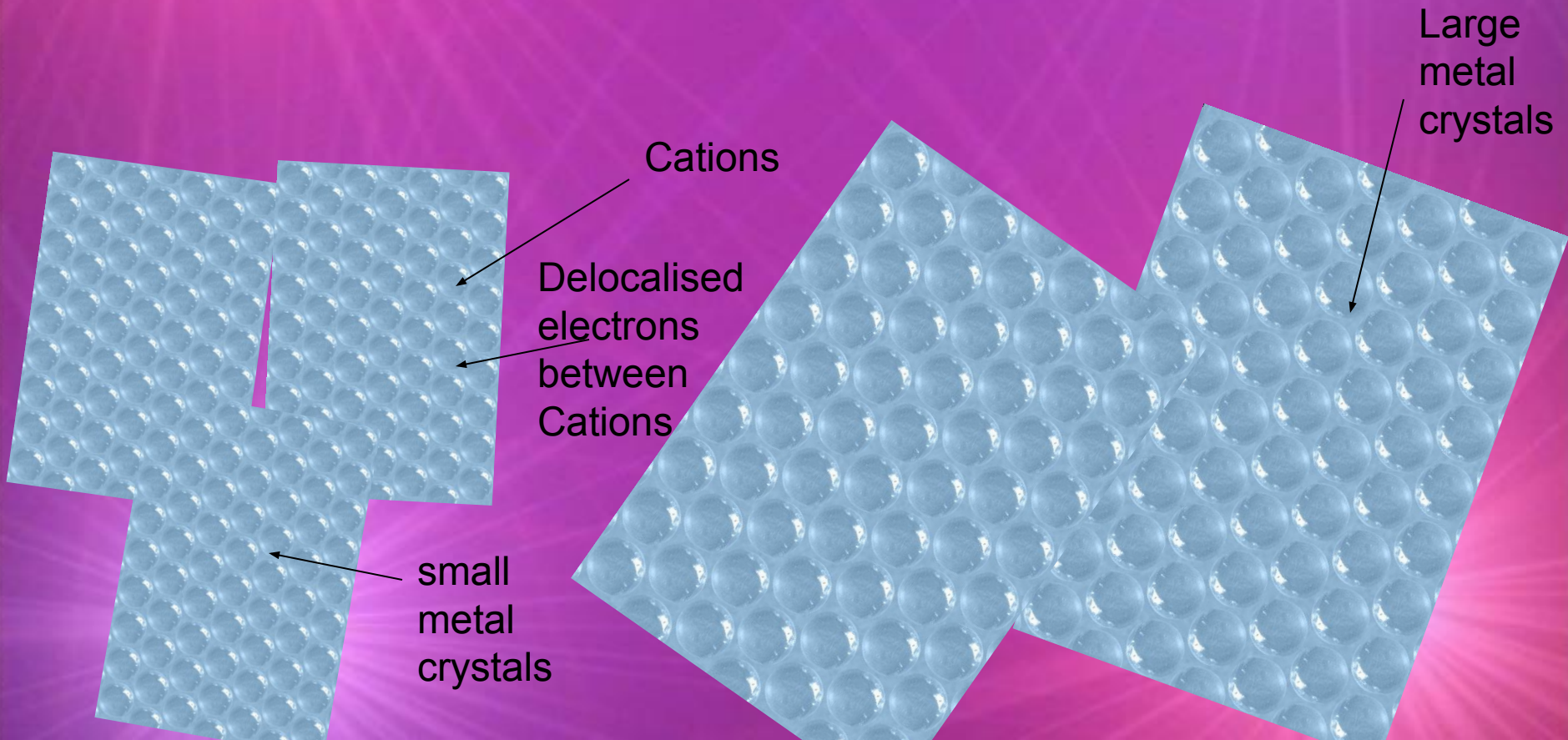
This attraction extends throughout the lattice and is called **metallic bonding**.

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

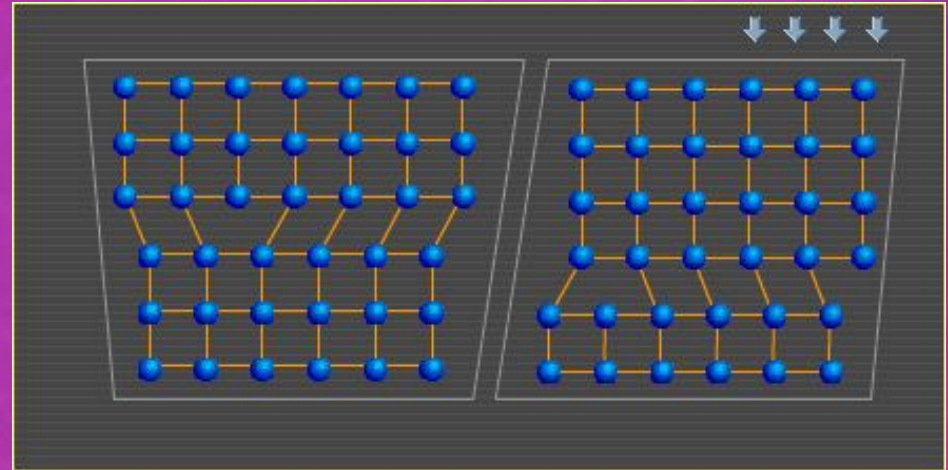
Metal crystals model

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

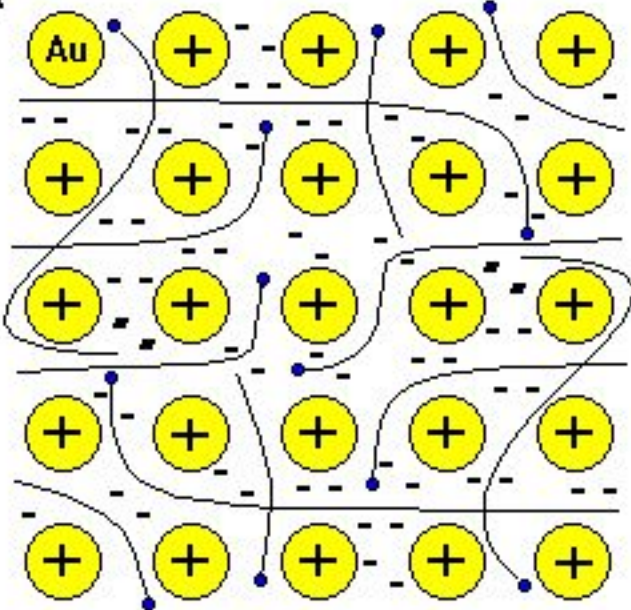


Piece of metal □ metal crystals □ lattice of ions and electrons

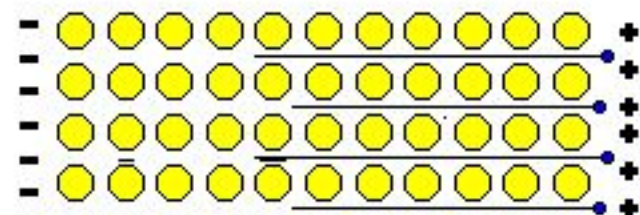
- The Metallic bonding model refers the arrangement of particles (electrons etc) in one metal crystal.
- A piece of a metal consists of a large number of crystals.
- Where one crystal meets another the regular lattice is disrupted



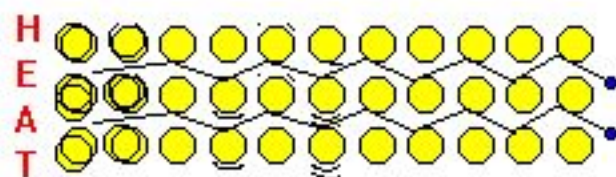
A



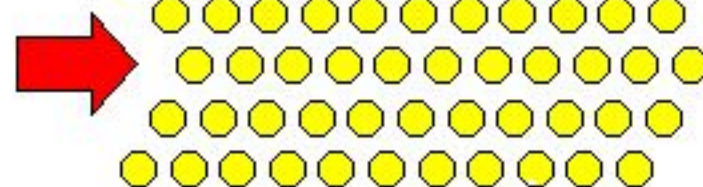
B



C



D



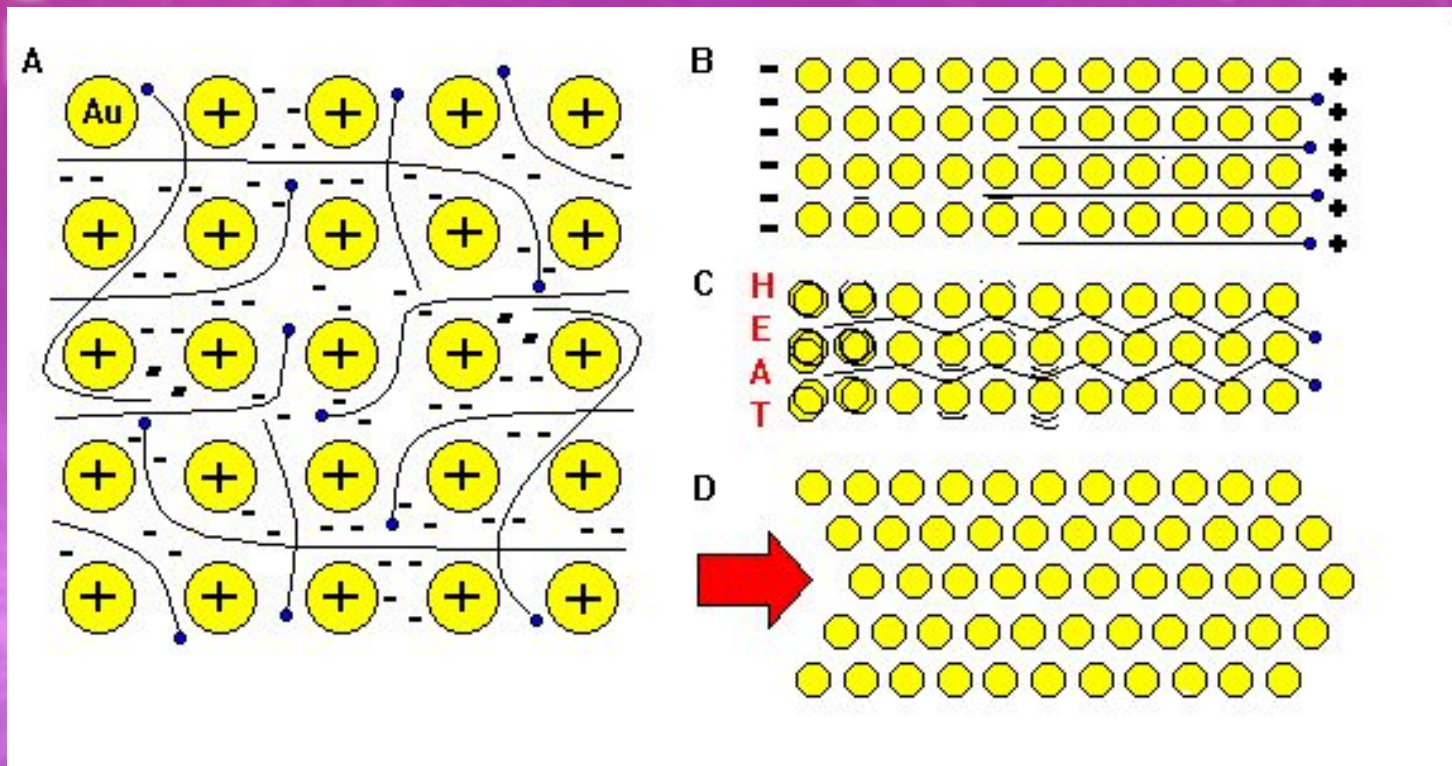
Explaining properties of metals

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. interstitial

- 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

